CHAPTER 4

Resources, Comparative Advantage, and Income Distribution

If labor were the only factor of production, as the Ricardian model assumes, comparative advantage could arise only because of international differences in labor productivity. In the real world, however, while trade is partly explained by differences in labor productivity, it also reflects differences in countries' *resources*. Canada exports forest products to the United States not because its lumberjacks are more productive relative to their U.S. counterparts than other Canadians but because sparsely populated Canada has more forested land per capita than the United States. A realistic view of trade must allow for the importance not just of labor, but of other factors of production such as land, capital, and mineral resources.

To explain the role of resource differences in trade, this chapter examines a model in which resource differences are the *only* source of trade. This model shows that comparative advantage is influenced by the interaction between nations' resources (the relative **abundance** of factors of production) and the technology of production (which influences the relative **intensity** with which different factors of production are used in the production of different goods).

That international trade is largely driven by differences in countries' resources is one of the most influential theories in international economics. Developed by two Swedish economists, Eli Heckscher and Bertil Ohlin (Ohlin received the Nobel Prize in economics in 1977), the theory is often referred to as the **Heckscher-Ohlin theory.** Because the theory emphasizes the interplay between the proportions in which different factors of production are available in different countries and the proportions in which they are used in producing different goods, it is also referred to as the **factor-proportions theory.**

To develop the factor-proportions theory, we begin by describing an economy that does not trade, then ask what happens when two such economies trade with each other. Since the factor-proportions theory is both an important theory and a controversial one, the chapter concludes with a discussion of the empirical evidence for and against the theory.

Learning Goals

After reading this chapter, you will be able to:

- Explain how differences in resources can cause international trade.
- Discuss why trade often creates losers as well as winners.
- Understand the meaning of gains from trade when there are losers.
- Discuss the reasons why trade is a politically contentious issue and the arguments for free trade despite the existence of losers.

A Model of a Two-Factor Economy

In this chapter, we'll focus on the simplest version of the factor-proportions model, sometimes referred to as "2 by 2 by 2": two countries, two goods, two factors of production. In our example we'll call the two countries Home and Foreign. The two goods will be cloth (measured in yards) and food (measured in calories). The two factors of production will be land (measured in acres) and labor (measured in hours).

Prices and Production

When there is more than one factor of production, the *production possibilities frontier* we introduced in Chapter 3 is no longer a straight line. To understand why, let's define the following expressions:

a_{TC} = acres of land used to produce one yard of cloth
a_{LC} = hours of labor used to produce one yard of cloth
a_{TF} = acres of land used to produce one calorie of food
a_{LF} = hours of labor used to produce one calorie of food
L = economy's supply of labor
T = economy's supply of land

Notice that we speak in these definitions of the quantity of land or labor *used* to produce a given amount of cloth or food, rather than the quantity *required* to produce that amount. The reason for this change from the Ricardian model is that when there are two factors of production, there may be some room for choice in the use of inputs.

Before we get to the implications of these choices, however, let's look at the special case in which there is only one way to produce each good—that is, producing a yard of cloth requires a fixed quantity of land and labor, as does producing a calorie of food, and there is no possibility of substituting land for labor and vice versa.

We assume that the ratio of labor to land used in the production of cloth is higher than the ratio of labor to land used in the production of food. That is,

$$a_{LC}/a_{TC} > a_{LF}/a_{TF} \tag{4-1}$$

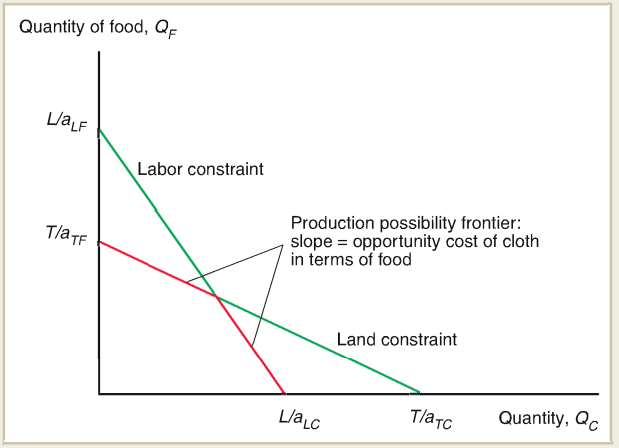
which can be rearranged as

$$a_{LC}/a_{LF} > a_{TC}/a_{TF} \tag{4-2}$$

Figure 4-1

The Production Possibility Frontier Without Factor Substitution

If land could not be substituted for labor or vice versa, the production possibility frontier in the factor proportions model would be defined by two resource constraints: The economy can't use more than the available supply of labor or land. So the production possibility frontier is defined by the red line in this figure. The important feature of this frontier is that the opportunity cost of cloth in terms of food isn't constant: It rises as the economy's mix of production shifts toward cloth.



In the Ricardian model, there was only one resource constraint on production. Here there are two. First, the total land used in production cannot exceed the total supply of land:

$$Q_F \times a_{TF} + Q_C \times a_{TC} \leq T \tag{4-3}$$

where Q_F is production of food and Q_C is production of cloth. Second, the total labor used in production cannot exceed the total supply of labor:

$$Q_F \times a_{LF} + Q_C \times a_{LC} \leq L \tag{4-4}$$

Figure 4-1 shows the implications of (4-3) and (4-4) for production possibilities. Each resource constraint is drawn in the same way that we drew the production possibility line in Figure 3-1. In this case, however, the economy must produce subject to *both* constraints. So the production possibility frontier is the kinked line shown in red. The important feature of this production possibility frontier is that the opportunity cost of producing an extra yard of cloth in terms of food isn't constant: It's low when the economy produces little cloth and a lot of food, but it is high when the economy produces a lot of cloth and little food.

Now let's make the model more realistic and allow the possibility of substituting land for labor and vice versa in production. This removes the kink in the production possibility frontier; instead, the frontier *PP* has the bowed shape shown in Figure 4-2. The bowed shape tells us that the opportunity cost in terms of food of producing one more unit of cloth rises as the economy produces more cloth and less food. That is, our basic insight about how opportunity costs change with the mix of production remains valid.

Where on the production possibility frontier does the economy produce? It depends on prices. Specifically, the economy produces at the point that maximizes the value of production. Figure 4-3 shows what this implies. The value of the economy's production is

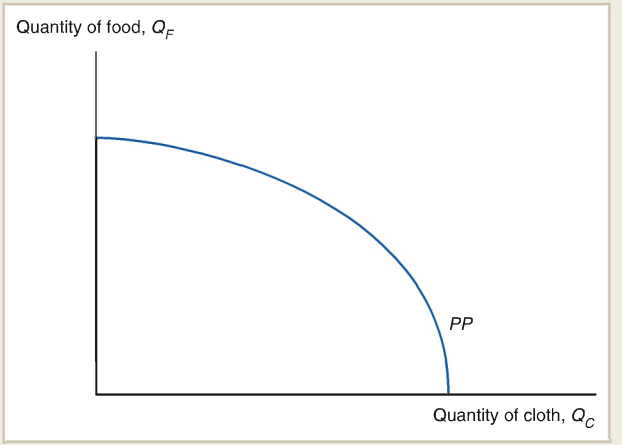
$$V = P_C \times Q_C + P_F \times Q_F$$

where P_C and P_F are the prices of cloth and food, respectively. An isovalue line—a line along which the value of output is constant—has a slope of $-P_C/P_F$. The economy

Figure 4-2

The Production Possibility Frontier with Factor Substitution

If land can be substituted for labor and vice versa, the production possibility frontier no longer has a kink. But it remains true that the opportunity cost of cloth in terms of food rises as the economy's production mix shifts toward cloth and away from food.



produces at the point Q, the point on the production possibility frontier that touches the highest possible isovalue line. At that point, the slope of the production possibility frontier is equal to $-P_C/P_F$. So the opportunity cost in terms of food of producing another unit of cloth is equal to the relative price of cloth.

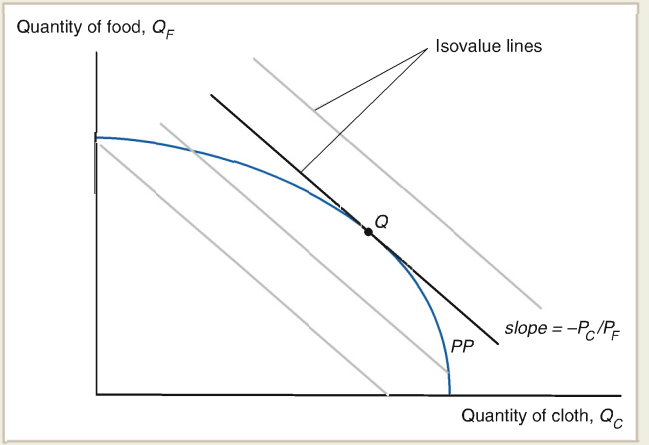
Choosing the Mix of Inputs

As we have noted, in a two-factor model producers may have room for choice in the use of inputs. A farmer, for example, may be able to grow more food per acre if he or she is willing to use more labor input to prepare the soil, weed, and so on. Thus the farmer may be able to choose to use less land and more labor per unit of output. In each sector, then,

Figure 4-3

Prices and Production

The economy produces at the point that maximizes the value of production given the prices it faces; this is the point that is on the highest possible isovalue line. At the point, the opportunity cost of cloth in terms of food is equal to the relative price of cloth, P_C/P_F.



producers will face not fixed input requirements (as in the Ricardian model) but trade-offs like the one illustrated by curve *II* in Figure 4-4, which shows alternative input combinations that can be used to produce one calorie of food.

What input choice will producers actually make? It depends on the relative cost of land and labor. If land rents are high and wages low, farmers will choose to produce using relatively little land and a lot of labor; if rents are low and wages high, they will save on labor and use a lot of land. If w is the wage rate per hour of labor and r the cost of one acre of land, then the input choice will depend on the ratio of these two **factor prices,** w/r.[1] The relationship between factor prices and the ratio of land to labor use in production of food is shown in Figure 4-5 as the curve *FF*.

There is a corresponding relationship between w/r and the land-labor ratio in cloth production. This relationship is shown in Figure 4-5 as the curve *CC*. As drawn, *CC* lies to the left of *FF* indicating that at any given factor prices production of food will always use a higher ratio of land to labor than production of cloth. When this is true, we say that production of food is *land-intensive*, while production of cloth is *labor-intensive*. Notice that the definition of intensity depends on the ratio of land to labor used in production, not the ratio of land or labor to output. Thus a good cannot be both land- and labor-intensive.

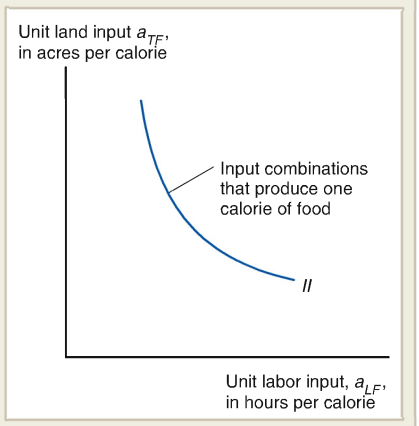
Factor Prices and Goods Prices

Suppose for a moment that the economy produces both cloth and food. (This need not be the case if the economy engages in international trade, because it might specialize completely in producing one good or the other; but let us temporarily ignore this possibility.) Then competition among producers in each sector will ensure that the price of each good equals its cost of production. The cost of producing a good depends on factor prices: If the rental rate on land is higher, then other things equal the price of any good whose production involves land input will also have to be higher.

Figure 4-4

Input Possibilities in Food Production

A farmer can produce a calorie of food with less land if he or she uses more labor, and vice versa.

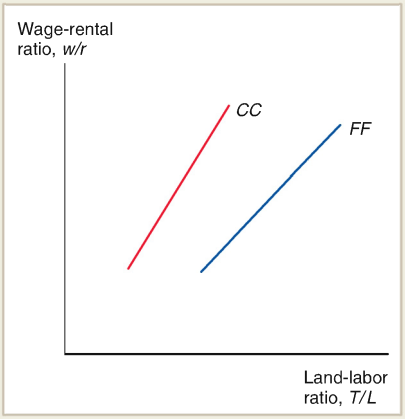


[1] The optimal choice of the land-labor ratio is explored at greater length in the appendix to this chapter.

Figure 4-5

Factor Prices and Input Choices

In each sector, the ratio of land to labor used in production depends on the cost of labor relative to the cost of land, *w/r*. The curve *FF* shows the land-labor ratio choices in food production, the curve *CC* the corresponding choices in cloth production. At any given wage-rental ratio, food production uses a higher land-labor ratio; when this is the case, we say that food production is *land-intensive* and that cloth production is *labor-intensive*.



The importance of a particular factor price to the cost of producing a good depends, however, on how much of that factor the good's production involves. If cloth production makes use of very little land, then a rise in the price of land will not have much effect on the price of cloth; whereas if food production uses a great deal of land, a rise in land prices will have a large effect on its price. We can therefore conclude that there is a one-to-one relationship between the ratio of the wage rate to the rental rate, w/r, and the ratio of the price of cloth to that of food, P_C/P_F. This relationship is illustrated by the upward-sloping curve *SS* in Figure 4-6.[2]

It is possible to put Figures 4-5 and 4-6 together. In Figure 4-7, the left panel is Figure 4-6 (of the *SS* curve) turned counterclockwise 90 degrees, while the right panel reproduces Figure 4-5. By putting these two diagrams together, we see what may seem at first to be a surprising linkage of the prices of goods to the ratio of land to labor used in the production of each good. Suppose that the relative price of cloth is $(P_C/P_F)^1$ (left panel of Figure 4-7); if the economy produces both goods, the ratio of the wage rate to the rental rate on land must equal $(w/r)^1$. This ratio then implies that the ratios of land to labor employed in the production of cloth and food must be $(T_C/L_C)^1$ and $(T_F/L_F)^1$, respectively (right panel of Figure 4-7). If the relative price of cloth were to rise to the level indicated by $(P_C/P_F)^2$, the ratio of the wage rate to the rental rate on land would rise to $(w/r)^2$. Because land is now relatively cheaper the ratios of land to labor employed in the production of cloth and food would therefore rise to $(T_C/L_C)^2$ and $(T_F/L_F)^2$.

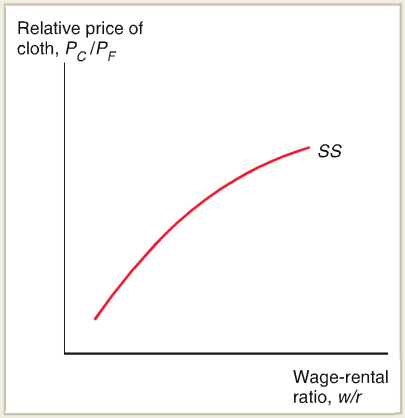
We can learn one more important lesson from this diagram. The left panel already tells us that an increase in the price of cloth relative to that of food will raise the income of workers relative to that of landowners. But it is possible to make a stronger statement: Such a change in relative prices will unambiguously raise the purchasing power of workers and lower the purchasing power of landowners by raising real wages and lowering real rents in terms of *both* goods.

[2] The relationship between goods prices and factor prices was clarified in a classic paper by Wolfgang Stolper and Paul Samuelson, "Protection and Real Wages," *Review of Economic Studies* 9 (1941), pp. 58–73, and is therefore known as the *Stolper-Samuelson effect*.

Figure 4-6

Factor Prices and Goods Prices

Because cloth production is labor-intensive while food production is land-intensive, there is a one-to-one relationship between the factor price ratio w/r and the relative price of cloth P_C/P_F; the higher the relative cost of labor, the higher must be the relative price of the labor-intensive good. The relationship is illustrated by the curve *SS*.



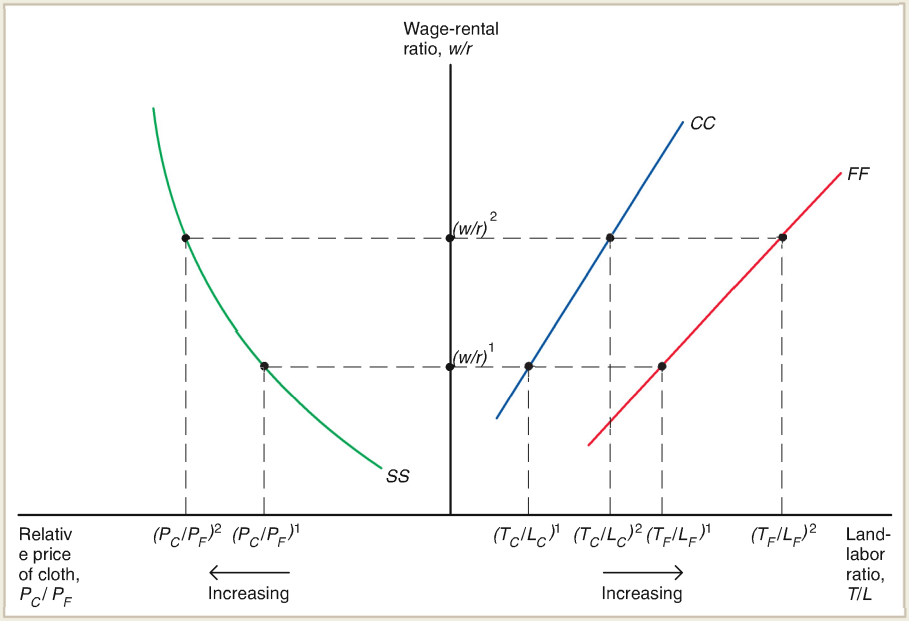


Figure 4-7

From Goods Prices to Input Choices

Given the relative price of cloth $(P_C/P_F)^1$ the ratio of the wage rate to the rental rate on land must equal $(w/r)^1$ This wage-rental ratio then implies that the ratios of land to labor employed in the production of cloth and food must be $(T_C/L_C)^1$ and $(T_F/L_F)^1$. If the relative price of cloth rises to $(P_C/P_F)^2$, the wage-rental ratio must rise to $(W/r)^2$. This will cause the land-labor ratio used in the production of both goods to rise.

How do we know this? When P_C/P_F increases, the ratio of land to labor rises in both cloth and food production. But in a competitive economy factors of production are paid their marginal product—the real wage of workers in terms of cloth is equal to the marginal productivity of labor in cloth production, and so on. When the ratio of land to labor rises in producing either good, the marginal product of labor in terms of that good increases—so workers find their real wage higher in terms of both goods. On the other hand, the marginal product of land falls in both industries, so landowners find their real income lower in terms of both goods.

In this model, then, as in the specific factors model, changes in relative prices have strong effects on income distribution. Not only does a change in goods prices change the distribution of income; it always changes it so much that owners of one factor of production gain while owners of the other are made worse off.

Resources and Output

We can now complete the description of a two-factor economy by describing the relationship between goods prices, factor supplies, and output.

Suppose that we take the relative price of cloth as given. We know from Figure 4-7 that this determines the wage-rental ratio w/r, and thus the ratio of land to labor used in the production of both cloth and food. But the economy must fully employ its supplies of labor and land. It is this last condition that determines the allocation of resources between the two industries and, therefore, the economy's output.

A convenient way to analyze the allocation of resources in a two-factor economy is to use a "box diagram" like Figure 4-8. The width of the box represents the economy's total supply of labor; the height of the box its total supply of land. The allocation of resources between two industries can be represented by a single point within the box, such as point 1. We measure the use of labor and land in the cloth sector as the horizontal and vertical distances of such a point from O_C; thus at point 1 O_CL_C is the labor used in cloth production and O_CT_C is the land used in cloth production. We measure inputs into the food sector starting from the opposite corner: O_FL_F is the labor and O_FT_F is the land used in food production.

How can we determine the location of this resource allocation point? From Figure 4-7 we know that given goods prices, we can determine the ratio of land to labor in cloth production, T_C/L_C. Draw a straight line from O_C whose slope equals that land-labor ratio, such as the line O_CC; point 1 must lie on this line. Similarly, the known land-labor ratio in food production determines the slope of another line, O_FF; point 1 must also lie on *this* line. (O_FF is steeper than O_CC because, as we saw earlier, the ratio of land to labor is higher in food than in cloth production.) Thus the economy's resource allocation is identified by the point at which the two lines representing land-labor ratios cross—here, at point 1.[3]

Given the prices of cloth and food and the supplies of land and labor, then, it is possible to determine how much of each resource the economy devotes to the production of each good, and thus also to determine the economy's output of each good. The next question is how these outputs change when the economy's resources change.

[3] Some readers may notice that O_CC and O_FF need not intersect inside the box. What happens then? The answer is that in that case the economy specializes in producing only one good and uses all its land and labor to produce that good. Remember that the relationship between goods prices and factor prices shown in Figures 4-6 and 4-7 depends on the assumption that the economy is producing both goods.

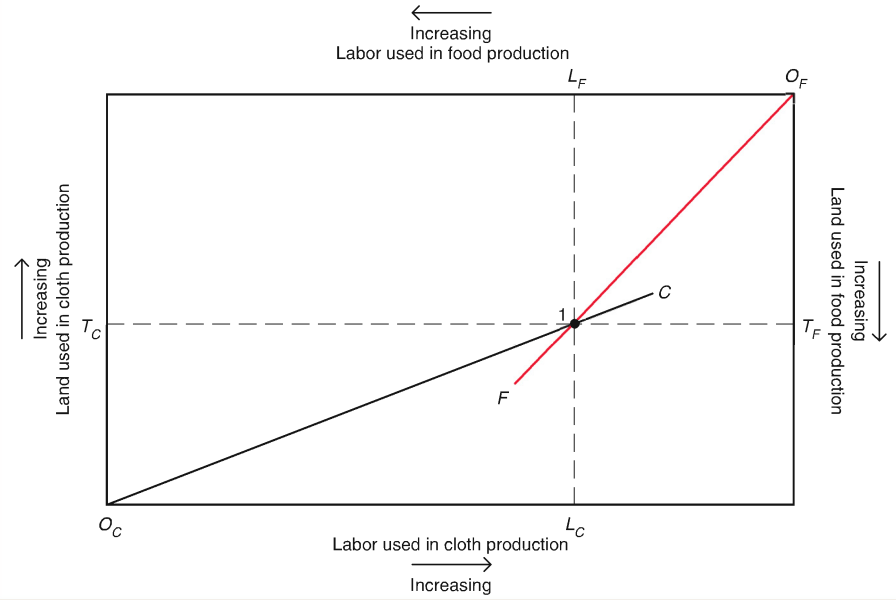


Figure 4-8

The Allocation of Resources

The sides of the box measure the economy's total supplies of labor (horizontal axis) and land (vertical axis). Inputs into cloth production are measured from the lower-left corner; inputs into food production from the upper-right corner. Given the land-labor ratio in cloth production, T_C/L_C, the cloth industry's employment of resources must lie on the line O_C/C, which is a line drawn from the origin with the slope T_C/L_C. Similarly, the food industry's employment of resources must lie on the line O_FF. The allocation of resources can therefore be read off from point 1, where these lines intersect.

The initially surprising answer is shown in Figure 4-9, which shows what happens when the economy's supply of land is increased, holding both goods prices and the labor supply fixed. With the increased supply of land, the box is taller. This means that inputs into food production can no longer be measured from O_F (now labeled O^1_F) but must be measured from the corner of the new, enlarged box, O^2_F, and the original line $O^1_FF^1$ must be replaced with $O^2_FF^2$. The resource allocation point must therefore move from 1 to 2.

What is surprising about this result? Notice that the quantities of labor and land used in cloth production actually *fall*, from L^1_C and T^1_C to L^2_C and T^2_C. Thus an increase in the economy's supply of land will, holding prices constant, lead to a fall in the output of the labor-intensive good. What happens to the land and labor no longer used in cloth production? It is now used in the food sector, whose output must have risen more than proportionately to the increase in land supply; for example, if land supply were to rise by 10 percent, food output might rise by 15 or 20 percent.

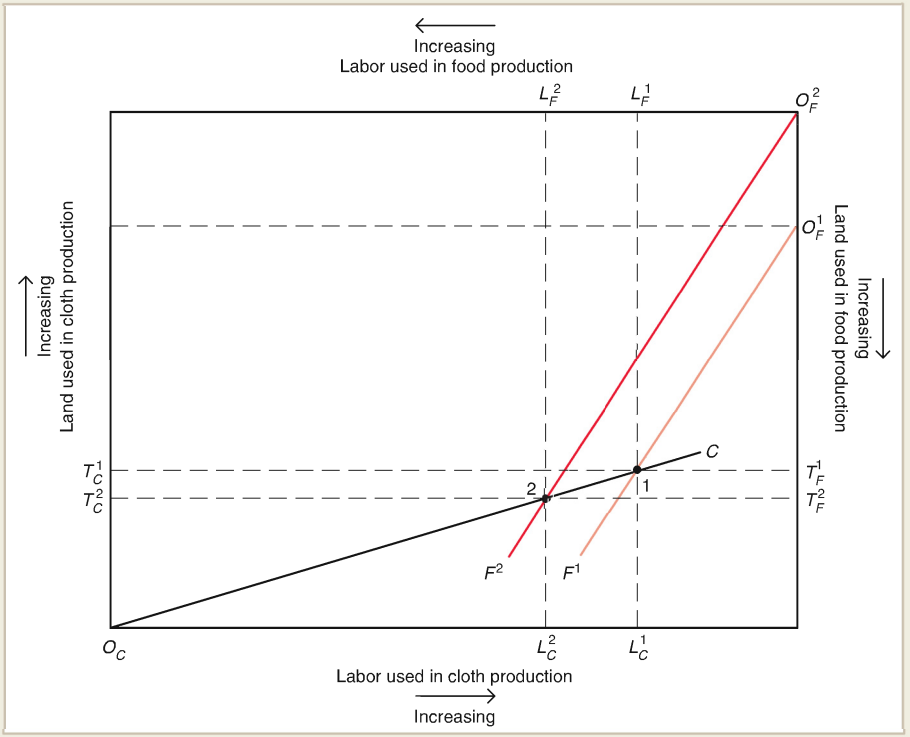


Figure 4-9

An Increase in the Supply of Land

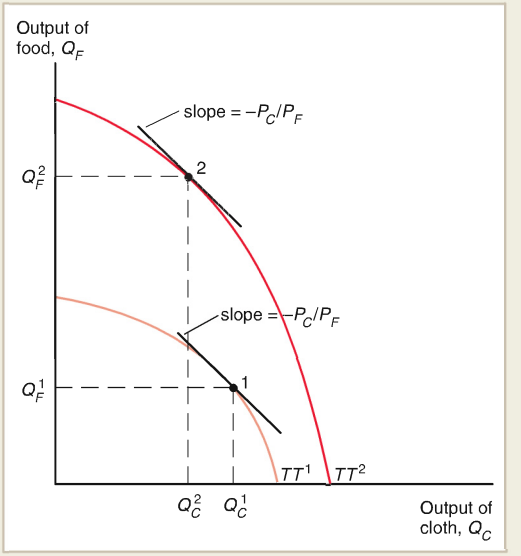
An increased land supply makes the box representing the economy's resources taller; resources allocated to food production must now be measured from $O^2{}_F$ if goods prices remain unchanged, and thus factor prices and land-labor ratios remain the same, resources allocation moves from point 1 to point 2, with more land and more labor devoted to food production. The output of clothing falls, while output of food rises more than proportionately to the increase in land supply.

The best way to think about this result is in terms of how resources affect the economy's production possibilities. In Figure 4-10 the curve TT^1 represents the economy's production possibilities before the increase in land supply. Output is at point 1, where the slope of the production possibility frontier equals minus the relative price of cloth, $-P_C/P_F$, and the economy produces Q_C^1 and Q_F^1 of cloth and food. The curve TT^2 shows the production possibility frontier after an increase in land supply. The production possibility frontier shifts out to TT^2, that is, the economy could produce more of both cloth and food than before. The outward shift of the frontier is, however, much larger in the direction of food than of clothing, that is, there is a **biased expansion of production possibilities** which occurs when the production possibility frontier shifts out much more in one direction than in the other. In this case, the expansion is so strongly biased toward food production that at unchanged

Figure 4-10

Resources and Production Possibilities

An increase in the supply of land shifts the economy's production possibility frontier outward from TT^1 to TT^2, but does so disproportionately in the direction of food production. The result is that at an unchanged relative price of cloth (Indicated by the slope $-P_C/P_{FT}$), cloth production actually declines from Q_C^1 to Q_C^2.



relative prices production moves from point 1 to point 2, which involves an actual fall in cloth output from Q_C^1 to Q_C^2 and a large increase in food output from Q_F^1 to Q_F^2.

The biased effect of increases in resources on production possibilities is the key to understanding how differences in resources give rise to international trade.[4] An increase in the supply of land expands production possibilities disproportionately in the direction of food production, while an increase in the supply of labor expands them disproportionately in the direction of cloth production. Thus an economy with a high ratio of land to labor will be relatively better at producing food than an economy with a low ratio of land to labor. *Generally, an economy will tend to be relatively effective at producing goods that are intensive in the factors with which the country is relatively well endowed.*

Effects of International Trade Between Two-Factor Economies

Having outlined the production structure of a two-factor economy, we can now look at what happens when two such economies, Home and Foreign, trade. As always, Home and Foreign are similar along many dimensions. They have the same tastes and therefore have identical relative demands for food and cloth when faced with the same relative price of the two goods. They also have the same technology: A given amount of land and labor yields the same

[4] The biased effect of resource changes on production was pointed out in a paper by the Polish economist T.M. Rybczynski, "Factor Endowments and Relative Commodity Prices," *Economica* 22(1955), pp. 336–341. It is therefore known as the *Rybczynski effect*.

output of either cloth or food in the two countries. The only difference between the countries is in their resources: Home has a higher ratio of labor to land than Foreign does.

Relative Prices and the Pattern of Trade

Since Home has a higher ratio of labor to land than Foreign, Home is *labor-abundant* and Foreign is *land-abundant*. Note that abundance is defined in terms of a ratio and not in absolute quantities. If the United States has 80 million workers and 200 million acres (a labor-to-land ratio of one-to-two-and-a-half) while Britain has 20 million workers and 20 million acres (a labor-to-land ratio of one-to-one), we consider Britain to be labor-abundant even though it has less total labor than the United States. "Abundance" is always defined in relative terms, by comparing the ratio of labor to land in the two countries, so that no country is abundant in everything.

Since cloth is the labor-intensive good, Home's production possibility frontier relative to Foreign's is shifted out more in the direction of cloth than in the direction of food. Thus, other things equal, Home tends to produce a higher ratio of cloth to food.

Because trade leads to a convergence of relative prices, one of the other things that will be equal is the price of cloth relative to food. Because the countries differ in their factor abundances, however, for any given ratio of the price of cloth to that of food Home will produce a higher ratio of cloth to food than Foreign will: Home will have a larger *relative supply* of cloth. Home's relative supply curve, then, lies to the right of Foreign's.

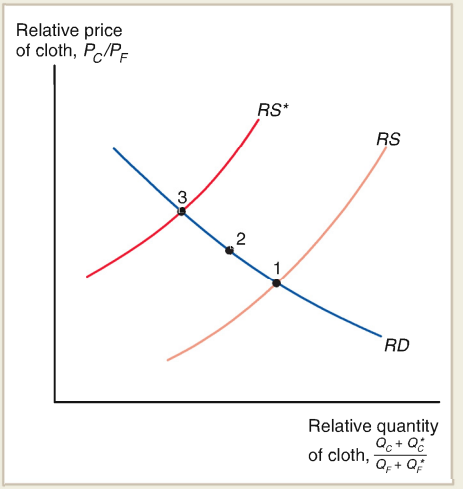
The relative supply schedules of Home (RS) and Foreign (RS^*) are illustrated in Figure 4-11. The relative demand curve, which we have assumed to be the same for both countries, is shown as RD. If there were no international trade, the equilibrium for Home would be at point 1, the equilibrium for Foreign at point 3. That is, in the absence of trade the relative price of cloth would be lower in Home than in Foreign.

When Home and Foreign trade with each other, their relative prices converge. The relative price of cloth rises in Home and declines in Foreign, and a new world relative price of cloth is established at a point somewhere between the pretrade relative prices, say at point 2.

Figure 4-11

Trade Leads to a Convergence of Relative Prices

In the absence of trade, Home's equilibrium would be at point 1, where domestic relative supply RS intersects the relative demand curve RD. Similarly, Foreign's equilibrium would be at point 3. Trade leads to a world relative price that lies between the pretrade prices, that is, at point 2.



If trade occurs initially because of differences in relative prices of cloth, how does the convergence of P_C/P_F translate into a pattern of international trade? To answer this question, we need to state some basic relationships among prices, production, and consumption.

In a country that cannot trade, the output of a good must equal its consumption. If D_C is consumption of cloth and D_F consumption of food, then in a closed economy $D_C = Q_C$ and $D_F = Q_F$. International trade makes it possible for the mix of cloth and food consumed to differ from the mix produced. While the amounts of each good that a country consumes and produces may differ, however, a country cannot spend more than it earns: The *value* of consumption must be equal to the value of production. That is,

$$P_C \times D_C + P_F \times D_F = P_C \times Q_C + P_F \times Q_F. \tag{4-5}$$

Equation (4-5) can be rearranged to yield the following:

$$D_F - Q_F = (P_C/P_F) \times (Q_C - D_C). \tag{4-6}$$

$D_F - Q_F$ is the economy's food *imports*, the amount by which its consumption of food exceeds its production. The right-hand side of the equation is the product of the relative price of cloth and the amount by which production of cloth exceeds consumption, that is, the economy's *exports* of cloth. The equation, then, states that imports of food equal exports of cloth times the relative price of cloth. While it does not tell us how much the economy will import or export, the equation does show that the amount the economy can afford to import is limited, or constrained, by the amount it exports. Equation (4-6) is therefore known as a **budget constraint.**[5]

Figure 4-12 illustrates two important features of the budget constraint for a trading economy. First, the slope of the budget constraint is minus P_C/P_F, the relative price of cloth. The reason is that consuming one less unit of cloth saves the economy P_C; this is enough to purchase P_C/P_F extra units of food. Second, the budget constraint is tangent to the production possibility frontier at the point that represents the economy's choice of production given the relative price of cloth, shown in the figure as point 1. That is, the economy can always afford to consume what it produces.

We can now use the budget constraints of Home and Foreign to construct a picture of the trading equilibrium. In Figure 4-13, we show the outputs, budget constraints, and consumption choices of Home and Foreign at equilibrium prices. In Home, the rise in the relative price of cloth leads to a rise in the consumption of food relative to cloth and a fall in the relative output of food. Home produces Q_F^1 of food but consumes D_F^1; it therefore becomes a cloth exporter and a food importer. In Foreign, the post-trade fall in the relative price of cloth leads to a rise in the consumption of cloth relative to food and a fall in the relative output of cloth; Foreign therefore becomes a cloth importer and a food exporter. In equilibrium Home's exports of cloth must exactly equal Foreign's imports and Home's imports of food exactly equal Foreign's exports. The qualities are shown by the equality of the two colored triangles in Figure 4-13.

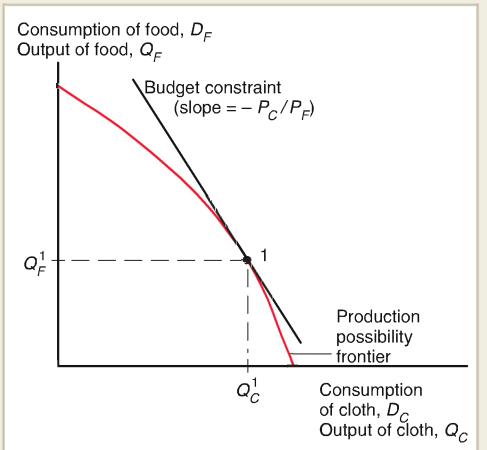
To sum up what we have learned about the pattern of trade: Home has a higher ratio of labor to land than Foreign; that is, Home is abundant in labor and Foreign is abundant in land.

[5] The constraint that the value of consumption equals that of production (or, equivalently, that imports equal exports in value) may not hold when countries can borrow from other countries or lend to them. For now we assume that these possibilities are not available and that the budget constraint (equation (4–6)) therefore holds. International borrowing and lending are examined in Chapter 7, which shows that an economy's consumption *over time* is still constrained by the necessity of paying its debts to foreign lenders.

Figure 4-12

The Budget Constraint for a Trading Economy

Point 1 represents the economy's production. The economy's consumption must lie along a line that passes through point 1 and has a slope equal to minus the relative price of cloth.



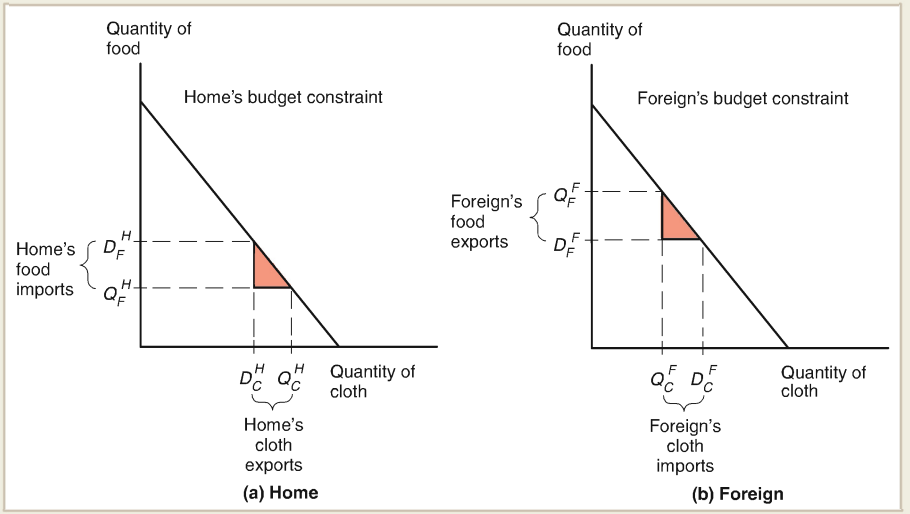


Figure 4-13

Trading Equilibrium

Home's imports of food are exactly equal to Foreign's exports, and Foreign's imports of cloth are exactly equal to Home's exports.

Cloth production uses a higher ratio of labor to land in its production than food; that is, cloth is labor-intensive and food is land-intensive. Home, the labor-abundant country, exports cloth, the labor-intensive good; Foreign, the land-abundant country, exports food, the land-intensive good. The general statement of the result is: *Countries tend to export goods whose production is intensive in factors with which they are abundantly endowed.*

Trade and the Distribution of Income

Trade produces a convergence of relative prices. Changes in relative prices, in turn, have strong effects on the relative earnings of labor and land. A rise in the price of cloth raises the purchasing power of labor in terms of both goods while lowering the purchasing power of land in terms of both goods. A rise in the price of food has the reverse effect. Thus international trade has a powerful effect on income distribution. In Home, where the relative price of cloth rises, people who get their income from labor gain from trade but those who derive their income from land are made worse off. In Foreign, where the relative price of cloth falls, the opposite happens: Laborers are made worse off and landowners are made better off.

The resource of which a country has a relatively large supply (labor in Home, land in Foreign) is the **abundant factor** in that country, and the resource of which it has a relatively small supply (land in Home, labor in Foreign) is the **scarce factor.** The general conclusion about the income distribution effects of international trade is: *Owners of a country's abundant factors gain from trade, but owners of a country's scarce factors lose.*

We will see shortly that the trade pattern of the United States suggests that compared with the rest of the world the United States is abundantly endowed with highly skilled labor and that low-skilled labor is correspondingly scarce. This means that international trade tends to make low-skilled workers in the United States worse off—not just temporarily, but on a sustained basis. The negative effect of trade on low-skilled workers poses a persistent political problem. Industries that use low-skilled labor intensively, such as apparel and shoes, consistently demand protection from foreign competition, and their demands attract considerable sympathy because low-skilled workers are relatively badly off to begin with.

Factor-Price Equalization

In the absence of trade, labor would earn less in Home than in Foreign, and land would earn more. Without trade, labor-abundant Home would have a lower relative price of cloth than land-abundant Foreign, and the difference in relative prices of *goods* implies an even larger difference in the relative prices of *factors*.

When Home and Foreign trade, the relative prices of goods converge. This convergence, in turn, causes convergence of the relative prices of land and labor. Thus there is clearly a tendency toward **equalization of factor prices.** How far does this tendency go?

The surprising answer is that in the model the tendency goes all the way. International trade leads to complete equalization of factor prices. Although Home has a higher ratio of labor to land than Foreign, once they trade with each other the wage rate and the rent on land are the same in both countries. To see this, refer back to Figure 4-6, which shows that given the prices of cloth and food we can determine the wage rate and the rental rate without reference to the supplies of land and labor. If Home and Foreign face the same relative prices of cloth and food, they will also have the same factor prices.

To understand how this equalization occurs, we have to realize that when Home and Foreign trade with each other more is happening than a simple exchange of goods. In an indirect way the two countries are in effect trading factors of production. Home lets

Foreign have the use of some of its abundant labor, not by selling the labor directly but by trading goods produced with a high ratio of labor to land for goods produced with a low labor-land ratio. The goods that Home sells require more labor to produce than the goods it receives in return; that is, more labor is *embodied* in Home's exports than in its imports. Thus Home exports its labor, embodied in its labor-intensive exports. Conversely, Foreign's exports embody more land than its imports, thus Foreign is indirectly exporting its land. When viewed this way, it is not surprising that trade leads to equalization of the two countries' factor prices.

Although this view of trade is simple and appealing, there is a major problem: In the real world factor prices are *not* equalized. For example, there is an extremely wide range of wage rates across countries (Table 4-1). While some of these differences may reflect differences in the quality of labor, they are too wide to be explained away on this basis alone.

To understand why the model doesn't give us an accurate prediction, we need to look at its assumptions. Three assumptions crucial to the prediction of factor-price equalization are in reality certainly untrue. These are the assumptions that (1) both countries produce both goods; (2) technologies are the same; and (3) trade actually equalizes the prices of goods in the two countries.

1. To derive the wage and rental rates from the prices of cloth and food in Figure 4-6, we assumed that the country produced both goods. This need not, however, be the case. A country with a very high ratio of labor to land might produce only cloth, while a country with a very high ratio of land to labor might produce only food. This implies that factor-price equalization occurs only if the countries involved are sufficiently similar in their relative factor endowments. (A more thorough discussion of this point is given in the appendix to this chapter.) Thus, factor prices need not be equalized between countries with radically different ratios of capital to labor or of skilled to unskilled labor.

2. The proposition that trade equalizes factor prices will not hold if countries have different technologies of production. For example, a country with superior technology might have both a higher wage rate and a higher rental rate than a country with an inferior technology. As described later in this chapter, recent work suggests that it is essential to allow for such differences in technology to reconcile the factor-proportions model with actual data on world trade.

TABLE 4-1 Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Production Workers, 2005
United States	100
Germany	140
Japan	92
Spain	75
South Korea	57
Portugal	31
Mexico	11
China*	3

* 2004

Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page*.

3. Finally, the proposition of complete factor-price equalization depends on complete convergence of the prices of goods. In the real world, prices of goods are not fully equalized by international trade. This lack of convergence is due to both natural barriers (such as transportation costs) and barriers to trade such as tariffs, import quotas, and other restrictions.

Trade and Income Distribution in the Short Run

In looking at the politics of trade policy, it's important to realize that we've been using a model in which the earnings of factors of production don't depend on which industry employs them: Workers earn the same wage in cloth and food production, and land receives the same rent in both industries. In the real world, the same factor of production may temporarily earn quite different amounts in different industries, because it takes time for factors to move between industries. Only in the long run, after there is time to move resources between industries, will earnings be equalized again.

International economists refer to factors of production that are "stuck" in an industry, at least temporarily, as **specific factors.** Because many factors are specific in the short run, the distinction between the short run and the long run is very important in practice. Suppose that trade will lead to a fall in the relative price of cloth. In our long-run model this is good for landowners and bad for workers. But in the short run owners of land that is currently used in cloth production may suffer, while workers who are currently producing food may gain. And such short-run gains and losses often seem to determine political positions in debates over trade policy.

Case Study

North-South Trade and Income Inequality

The distribution of wages in the United States has become considerably more unequal since the late 1970s. For example, between 1979 and 2001 the wage rate of workers at the 95th percentile (that is, those earning more than the bottom 95 percent but less than the top 5 percent) rose 29 percent after adjusting for inflation, while the wage rate of workers at the 10th percentile rose only 0.2 percent. Much of this increase in wage inequality was associated with a rise in the premium attached to education. In 1979, men with college degrees earned an hourly wage only 21 percent higher than that of men with only a high school education. By 2002, the college premium had widened to 44 percent.

Why has wage inequality increased? Many observers attribute the change to the growth of world trade and in particular to the growing exports of manufactured goods from newly industrializing economies (NIEs), such as South Korea and China. Until the 1970s trade between advanced industrial nations and less-developed economies—often referred to as "North-South" trade because most advanced nations are still in the temperate zone of the Northern Hemisphere—consisted overwhelmingly of an exchange of Northern manufactures for Southern raw materials and agricultural goods, such as oil and coffee. From 1970 onward, however, former raw material exporters increasingly began to sell manufactured goods to high-wage countries like the United States. As we learned in Chapter 2, developing countries have dramatically changed the kinds of goods they export, moving away from their traditional reliance on agricultural and mineral products to a focus on manufactured goods. While NIEs also provided a rapidly growing market for exports from the high-wage nations, the exports of the newly industrializing economies obviously differed greatly in factor intensity from their imports. Overwhelmingly, NIE

exports to advanced nations consisted of clothing, shoes, and other relatively unsophisticated products whose production is intensive in unskilled labor, while advanced-country exports to the NIEs consisted of capital- or skill-intensive goods such as chemicals and aircraft.

To many observers the conclusion seemed straightforward: What was happening was a move toward factor-price equalization. Trade between advanced countries that are abundant in capital and skill and NIEs with their abundant supply of unskilled labor was raising the wages of highly skilled workers and lowering the wages of less-skilled workers in the skill- and capital-abundant countries, just as the factor-proportions model predicts.

This is an argument with much more than purely academic significance. If one regards the growing inequality of income in advanced nations as a serious problem, as many people do, and if one also believes that growing world trade is the main cause of that problem, it becomes difficult to maintain the traditional support of economists for free trade. (As we point out below, in principle taxes and government payments can offset the effect of trade on income distribution, but one may argue that this is unlikely to happen in practice.) Some influential commentators have argued that advanced nations will have to restrict their trade with low-wage countries if they want to remain basically middle-class societies.

While some economists believe that growing trade with low-wage countries has been the main cause of growing inequality of income in the United States, however, most empirical workers believed at the time of writing that international trade has been at most a contributing factor to that growth, and that the main causes lie elsewhere.[6] This skepticism rests on three main observations.

First, the factor-proportions model says that international trade affects the income distribution via a change in relative goods prices. So if international trade was the main driving force behind growing income inequality, there ought to be clear evidence of a rise in the price of skill-intensive products compared with those of unskilled-labor-intensive goods. Studies of international price data, however, failed to find clear evidence of such a change in relative prices.

Second, the model predicts that relative factor prices should converge: If wages of skilled workers are rising and those of unskilled workers are falling in the skill-abundant country, the reverse should be happening in the labor-abundant country. Studies of income distribution in developing countries that have opened themselves to trade have shown that at least in some cases the reverse was true. In Mexico, in particular, careful studies have shown that the transformation of the country's trade in the late 1980s—Mexico opened itself to imports and became a major exporter of manufactured goods—was accompanied by rising wages for skilled workers and growing overall wage inequality, closely paralleling developments in the United States.

Third, although trade between advanced countries and NIEs has grown rapidly, it still constitutes only a small percentage of total spending in the advanced nations. As a result, estimates of the "factor content" of this trade—the skilled labor exported, in

[6] Among the important entries in the discussion of the impact of trade on income distribution have been Robert Lawrence and Matthew Slaughter, "Trade and U.S. Wages: Giant Sucking Sound or Small Hiccup?" *Brookings Papers on Economic Activity* 1: 1993; Jeffrey Sachs and Howard Shatz, "Trade and Jobs in U.S. Manufacturing," *Brookings Papers on Economic Activity* 1: 1994; and Adrian Wood, *North-South Trade, Employment, and Income Inequality,* Oxford: Clarendon, 1994. For a survey of this debate and related issues, see Robert Lawrence, *Single World, Divided Nations: Globalization and OECD Labor Markets,* Paris: OECD, 1995.

effect, by advanced countries embodied in skill-intensive exports, and the unskilled labor, in effect, imported in labor-intensive exports—are still only a small fraction of the total supplies of skilled and unskilled labor. This suggests that these trade flows cannot have had a very large impact on income distribution.

What, then, *is* responsible for the growing gap between skilled and unskilled workers in the United States? The view of the majority is that the villain is not trade but technology, which has devalued less-skilled work. The view that trade is in fact the main explanation still has a number of adherents, however.

The Political Economy of Trade: A Preliminary View

In Chapter 3 we offered a sunny view of international trade: In the Ricardian model, everyone gains. But in the factor-proportions model, there are typically losers as well as winners from trade. In the short run, factors that are specific to industries that must compete with imports lose from trade. In the long run, a country's scarce factors lose from trade. Since we can no longer simply assert that trade benefits everyone, we need to take a deeper look at trade, asking three questions:

- In what sense can we even talk about gains from trade when some people lose?
- Given the fact that some people lose from trade, what *should* the government do?
- What are governments likely to do in practice?

The Gains from Trade, Revisited

Do the gains from trade outweigh the losses? One way you might try to answer this question would be to sum up the gains of the winners and the losses of the losers and compare them. The problem with this procedure is that we are comparing welfare, an inherently subjective thing. Suppose that workers are dull people who get hardly any satisfaction out of increased consumption, while landowners are bons vivants who get immense pleasure out of it. Then one might well imagine that trade reduces the total amount of pleasure in Home. But the reverse could equally be true. More to the point, it is outside the province of what we normally think of as economic analysis to try to figure out how much enjoyment individuals get out of their lives.

A better way to assess the overall gains from trade is to ask a different question: Could those who gain from trade compensate those who lose, and still be better off themselves? If so, then trade is *potentially* a source of gain to everyone.

To illustrate that trade is a source of potential gain for everyone, we proceed in three steps:

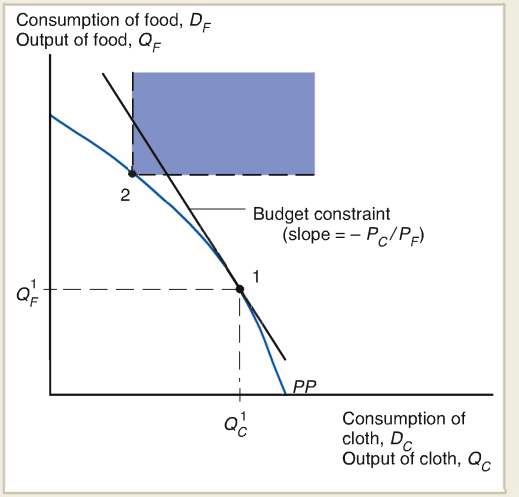
1. First, we notice that in the absence of trade the economy would have to produce what it consumed, and vice versa. Thus the *consumption* of the economy in the absence of trade would have to be a point on the *production* possibility frontier. In Figure 4-14, a typical pretrade consumption point is shown as point 2.

2. Next, we notice that it is possible for a trading economy to consume more of *both* goods than it would have in the absence of trade. The budget constraint in Figure 4-14

Figure 4-14

Trade Expands the Economy's Consumption Possibilities

Before trade, economy's production and consumption were at point 2 on its production possibilities frontier (*PP*). After trade, the economy can consume at any point on its budget constraint. The portion of the budget constraint in the colored region consists of feasible post-trade consumption choices with consumption of both goods higher than at the pretrade point 2.



represents all the possible combinations of food and cloth that the country could consume given the world relative price of cloth. Part of that budget constraint—the part in the colored region—represents situations in which the economy consumes more of both cloth and food than it could in the absence of trade. Notice that this result does not depend on the assumption that pretrade production and consumption was at point 2; unless pretrade production was at point 1, so that trade has no effect on production at all, there is always a part of the budget constraint that allows consumption of more of both goods.

3. Finally, observe that if the economy as a whole consumes more of both goods, then it is possible in principle to give each *individual* more of both goods. This would make everyone better off. This shows, then, that it is possible to ensure that everyone is better off as a result of trade. Of course, everyone might be still better off if they had less of one good and more of the other, but this only reinforces the conclusion that everyone can potentially gain from trade.

The fundamental reason why trade potentially benefits a country is that it *expands the economy's choices*. This expansion of choice means that it is always possible to redistribute income in such a way that everyone gains from trade.[7]

That everyone *could* gain from trade unfortunately does not mean that everyone actually does. In the real world, the presence of losers as well as winners from trade is one of the most important reasons why trade is not free.

Optimal Trade Policy

Suppose a government wants to maximize the welfare of its population. If everyone were exactly the same in tastes and in income there would be a straightforward solution:

[7] The argument that trade is beneficial because it enlarges an economy's choices is much more general than this picture. For a thorough discussion, see Paul Samuelson, "The Gains from International Trade Once Again," *Economic Journal* 72 (1962), pp. 820–829.

The government would choose policies that make the representative individual as well off as possible. In this homogeneous economy, free international trade would clearly serve the government's objective.

When people are not exactly alike, however, the government's problem is less well defined. The government must somehow weigh one person's gain against another person's loss. If, for example, the Home government is relatively more concerned about hurting landowners than about helping workers, then international trade, which in our analysis benefited labor and hurt landowners in Home, might be a bad thing from the Home government's point of view.

There are many reasons why one group might matter more than another, but one of the most compelling reasons is that some groups need special treatment because they are already relatively poor. There is widespread sympathy in the United States for restrictions on imports of garments and shoes, even though the restrictions raise consumer prices, because workers in these industries are already poorly paid. The gains that affluent consumers would realize if more imports were allowed do not matter as much to the U.S. public as the losses low-paid shoe and garment workers would suffer.

Does this mean that trade should be allowed only if it doesn't hurt lower-income people? Few international economists would agree. In spite of the real importance of income distribution, most economists remain strongly in favor of more or less free trade. There are three main reasons why economists do *not* generally stress the income distribution effects of trade:

1. Income distribution effects are not specific to international trade. Every change in a nation's economy, including technological progress, shifting consumer preferences, exhaustion of old resources and discovery of new ones, and so on, affects income distribution. If every change in the economy were allowed only after it had been examined for its distributional effects, economic progress could easily end up snarled in red tape.
2. It is always better to allow trade and compensate those who are hurt by it than to prohibit the trade. (This applies to other forms of economic change as well.) All modern industrial countries provide some sort of "safety net" of income support programs (such as unemployment benefits and subsidized retraining and relocation programs) that can cushion the losses of groups hurt by trade. Economists would argue that if this cushion is felt to be inadequate, more support rather than less trade is the right answer.
3. Those who stand to lose from increased trade are typically better organized than those who stand to gain. This imbalance creates a bias in the political process that requires a counterweight. It is the traditional role of economists to strongly support free trade, pointing to the overall gains; those who are hurt usually have little trouble making their complaints heard.

Most economists, then, while acknowledging the effects of international trade on income distribution, believe that it is more important to stress the potential gains from trade than the possible losses to some groups in a country. Economists do not, however, often have the deciding voice in economic policy, especially when conflicting interests are at stake. Any realistic understanding of how trade policy is determined must look at the actual motivations of policy.

Income Distribution and Trade Politics

It is easy to see why groups that lose from trade lobby their governments to restrict trade and protect their incomes. You might expect that those who gain from trade would lobby as strongly as those who lose from it, but this is rarely the case. In the United States and in most countries, those who want trade limited are more effective politically than those who

want it extended. Typically, those who gain from trade in any particular product are a much less concentrated, informed, and organized group than those who lose.

A good example of this contrast between the two sides is the U.S. sugar industry. The United States has limited imports of sugar for many years; at the time of writing the price of sugar in the U.S. market was about 60 percent above its price in the world market. Estimates put the cost of U.S. consumers of this import limitation at about $1.5 billion a year—that is, about $6 a year for every man, woman, and child. The gains to producers are much smaller, probably less than half as large.

If producers and consumers were equally able to get their interests represented, this policy would never have been enacted. In absolute terms, however, each consumer suffers very little. Six dollars a year is not much; furthermore, most of the cost is hidden, because most sugar is consumed as an ingredient in other foods rather than purchased directly. Thus most consumers are unaware that the import quota even exists, let alone that it reduces their standard of living. Even if they were aware, $6 is not a large enough sum to provoke people into organizing protests and writing letters to their congressional representatives.

The sugar producers' situation is quite different. The average sugar producer gains thousands of dollars a year from the import quota. Furthermore, sugar producers are organized into trade associations and cooperatives that actively pursue their members' political interests. So the complaints of sugar producers about the effects of imports are loudly and effectively expressed.

As we will see in Chapters 8 through 11, the politics of import restriction in the sugar industry are an extreme example of a kind of political process that is common in international trade. That world trade in general became steadily freer from 1945 to 1980 depended, as we will see in Chapter 9, on a special set of circumstances that controlled what is probably an inherent political bias against international trade.

Empirical Evidence on the Heckscher-Ohlin Model

Since the factor-proportions theory of trade is one of the most influential ideas in international economics, it has been the subject of extensive empirical testing.

Testing the Heckscher-Ohlin Model

Tests on U.S. Data Until recently, and to some extent even now, the United States has been a special case among countries. The United States was until a few years ago much wealthier than other countries, and U.S. workers visibly worked with more capital per person than their counterparts in other countries. Even now, although some Western European countries and Japan have caught up, the United States continues to be high on the scale of countries as ranked by capital-labor ratios.

One would expect, then, that the United States would be an exporter of capital-intensive goods and an importer of labor-intensive goods. Surprisingly, however, this was not the case in the 25 years after World War II. In a famous study published in 1953, economist Wassily Leontief (winner of the Nobel Prize in 1973) found that U.S. exports were less capital-intensive than U.S. imports.[8] This result is known as the **Leontief paradox.** It is the single biggest piece of evidence against the factor-proportions theory.

[8] See Wassily Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-Examined," *Proceedings of the American Philosophical Society* 97 (1953), pp. 331–349.

Income Distribution and the Beginnings of Trade Theory

The modern theory of international trade began with the demonstration by David Ricardo, writing in 1817, that trade is mutually beneficial to countries. We studied Ricardo's model in Chapter 3. Ricardo used his model to argue for free trade, in particular for an end to the tariffs that restricted England's imports of food. Yet almost surely the British economy of 1817 was better described by a model with several factors of production than by the one-factor model Ricardo presented.

To understand the situation, recall that from the beginning of the French Revolution in 1789 until the defeat of Napoleon at Waterloo in 1815, Britain was almost continuously at war with France. This war interfered with Britain's trade: Privateers (pirates licensed by foreign governments) raided shipping and the French attempted to impose a blockade on British goods. Since Britain was an exporter of manufactures and an importer of agricultural products, this limitation of trade raised the relative price of food in Britain. Workers' wages and the profits of manufacturers suffered, but landowners actually prospered during the long war.

After the war, food prices in Britain fell. To avoid the consequences, the politically influential landowners were able to get legislation, the so-called Corn Laws, that imposed fees to discourage importation of grain. It was against these Corn Laws that Ricardo was arguing.

Ricardo knew that repeal of the Corn Laws would make capitalists better off but landowners worse off. From his point of view this was all to the good; a London businessperson himself, he preferred hard-working capitalists to idle landed aristocrats. But he chose to present his argument in the form of a model that assumed away issues of internal income distribution.

Why did he do this? Almost surely the answer is political: While Ricardo was in reality to some extent representing the interest of a single group, he emphasized the gains to the nation as a whole. This was a clever and thoroughly modern strategy, one that pioneered the use of economic theory as a political instrument. Then as now, politics and intellectual progress are not incompatible: The Corn Laws were repealed more than a century and a half ago, yet Ricardo's model of trade remains one of the great insights in economics.

Table 4-2 illustrates the Leontief paradox as well as other information about U.S. trade patterns. We compare the factors of production used to produce $1 million worth of 1962 U.S. exports with those used to produce the same value of 1962 U.S. imports. As the first two lines in the table show, Leontief's paradox was still present in that

TABLE 4-2 Factor Content of U.S. Exports and Imports for 1962

	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

Source: Robert Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review* 61 (March 1971), pp. 126–145.

year: U.S. exports were produced with a lower ratio of capital to labor than U.S. imports. As the rest of the table shows, however, other comparisons of imports and exports are more in line with what one might expect. The United States exported products that were more *skilled* labor-intensive than its imports as measured by average years of education. We also tended to export products that were "technology-intensive," requiring more scientists and engineers per unit of sales. These observations are consistent with the position of the United States as a high-skill country, with a comparative advantage in sophisticated products.

Why, then, do we observe the Leontief paradox? No one is quite sure. A plausible explanation, however, might be the following: The United States has a special advantage in producing new products or goods made with innovative technologies such as aircraft and sophisticated computer chips. Such products may well be *less* capital-intensive than products whose technology has had time to mature and become suitable for mass production techniques. Thus the United States may be exporting goods that heavily use skilled labor and innovative entrepreneurship, while importing heavy manufactures (such as automobiles) that use large amounts of capital.[9]

Tests on Global Data Economists have also attempted to test the Heckscher-Ohlin model using data for a large number of countries. An important study by Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas[10] was based on the idea, described earlier, that trading goods is actually an indirect way of trading factors of production. Thus if we were to calculate the factors of production embodied in a country's exports and imports, we should find that a country is a net exporter of the factors of production with which it is relatively abundantly endowed and a net importer of those with which it is relatively poorly endowed.

Table 4-3 shows one of the key tests of Bowen et al. For a sample of 27 countries and 12 factors of production, the authors calculated the ratio of each country's endowment of each factor to the world supply. They then compared these ratios with each country's share of world income. If the factor-proportions theory was right, a country would always export factors for which the factor share exceeded the income share, and import factors for which it was less. In fact, for two-thirds of the factors of production, trade ran in the predicted direction less than 70 percent of the time. This result confirms the Leontief paradox on a broader level: Trade often does not run in the direction that the Heckscher-Ohlin theory predicts.

Comparisons of Southern and Northern Exports Although the overall pattern of international trade does not seem to be very well accounted for by a pure Heckscher-Ohlin model, comparisons of the exports of labor-abundant, skill-scarce nations in the third world with the exports of skill-abundant, labor-scarce nations do fit the theory quite well. Consider, for example, Figure 4-15, which compares the pattern of U.S. imports from Bangladesh, whose work force has low levels of education, with the pattern of U.S. imports from Germany, which has a highly educated labor force.

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[9] Later studies point to the disappearance of the Leontief paradox by the early 1970s. For example, see Robert M. Stern and Keith E. Maskus, "Determinants of the Structure of U.S. Foreign Trade, 1958–76," *Journal of International Economics* 11 (May 1981), pp. 207–224. These studies show, however, the continuing importance of *human* capital in explaining U.S. exports.

[10] See Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *American Economic Review* 77 (December 1987), pp. 791–809.

TABLE 4-3 Testing the Heckscher-Ohlin Model

Factor of Production	Predictive Success*
Capital	0.52
Labor	0.67
Professional workers	0.78
Managerial workers	0.22
Clerical workers	0.59
Sales workers	0.67
Service workers	0.67
Agricultural workers	0.63
Production workers	0.70
Arable land	0.70
Pasture land	0.52
Forest	0.70

* Fraction of countries for which net exports of factor runs in predicted direction.

Source: Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *American Economic Review* 77 (December 1987), pp. 791–809.

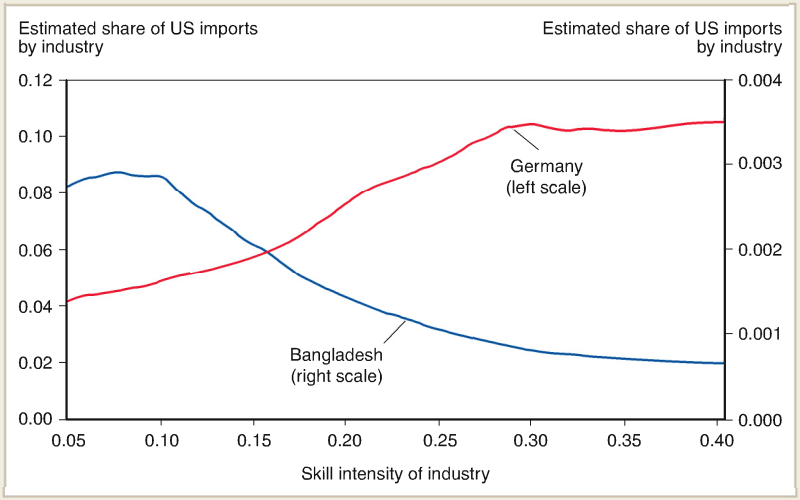

Figure 4-15

Skill Intensity and the Pattern of U.S. Imports from Two Countries

Source: John Romalis, "Factor Proportions and the Structure of Commodity Trade," *American Economic Review*, March 2004.

In Figure 4-15, which comes from the work of John Romalis of the University of Chicago[11], goods are ranked by skill intensity: the ratio of skilled to unskilled labor used in their production. The vertical axes of the figure show U.S. imports of each good from Germany and Bangladesh, respectively, as a share of total U.S. imports of that good. As you can see, Bangladesh tends to account for a relatively large share of U.S. imports of low-skill intensity goods such as clothing, but a low share of highly skill-intensive goods. Germany is in the reverse position.

Changes over time also follow the predictions of the Heckscher-Ohlin model. Figure 4-16 shows the changing pattern of exports to the United States from Western Europe, Japan, and the four Asian "miracle" economies—South Korea, Taiwan, Hong Kong, and Singapore—that moved rapidly from being quite poor economies in 1960 to relatively rich economies with highly skilled work forces today. Panel (a) of Figure 4-16 shows the pattern of exports from the three groups in 1960; the miracle economies were clearly specialized in exports of low-skill-intensity goods, and even Japan's exports were somewhat tilted toward the low-skill end. By 1998, however, the level of education of Japan's work force was comparable to that of Western Europe, and Japan's exports reflected that change, becoming as skill-intensive as those of European economies. Meanwhile, the four miracle economies, which had rapidly increased the skill levels of their own work forces, had moved to a trade pattern comparable to that of Japan a few decades earlier.

The Case of the Missing Trade In an influential paper, Daniel Trefler[12] pointed out a previously overlooked empirical problem with the Heckscher-Ohlin model. He noted that if one thinks about trade in goods as an indirect way of trading factors of production, this predicts not only the direction but the volume of that trade. Factor trade in general turns out to be much smaller than the Heckscher-Ohlin model predicts.

A large part of the reason for this disparity comes from a false prediction of large-scale trade in labor between rich and poor nations. Consider the United States, on one side, and China on the other. The United States has about 25 percent of world income but only about 5 percent of the world's workers; so a simple factor-proportions story would suggest that U.S. imports of labor embodied in trade should be huge, something like four times as large as the nation's own labor force. In fact, calculations of the factor content of U.S. trade show only small net imports of labor. Conversely, China has less than 3 percent of world income but approximately 15 percent of the world's workers; it therefore "should" export most of its labor via trade—but it does not.

Many trade economists now believe that this puzzle can be resolved only by dropping the Heckscher-Ohlin assumption that technologies are the same across countries. The way this resolution works is roughly as follows: If workers in the United States are much more efficient than those in China, then the "effective" labor supply in the United States is much larger compared with that of China than the raw data suggest—and hence the expected volume of trade between labor-abundant China and labor-scarce America is correspondingly less. As we pointed out earlier, technological differences across countries are also one likely explanation for the dramatic failure of factor-price equalization to hold, as documented in Table 4-1.

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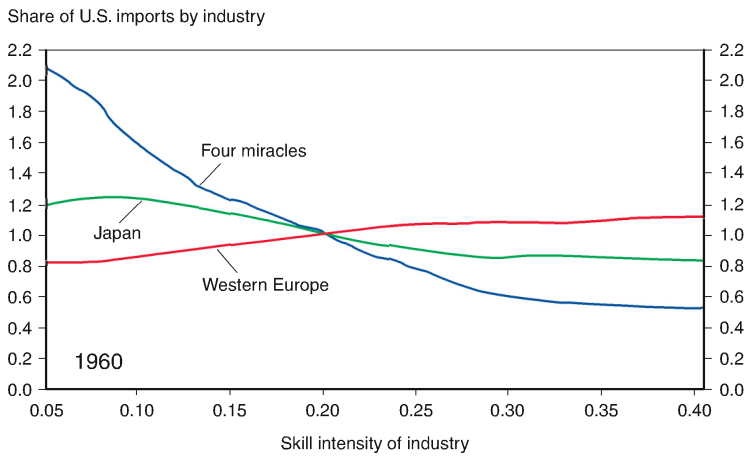
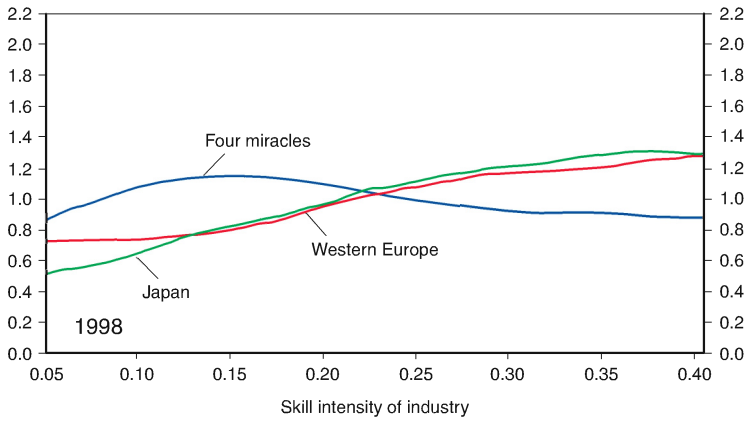
11 John Romalis, "Factor Proportions and the Structure of Commodity Trade," *American Economic Review*, vol. 94, no. 1 (March 2004), pp. 67–97.

12 Daniel Trefler, "The Case of the Missing Trade and Other Mysteries," *American Economic Review*, 85 (December 1995), pp. 1029–1046.



(a) 1960



(a) 1998

Figure 4-16
Changing Patterns of Comparative Advantage

TABLE 4-5 Estimated Technological Efficiency, 1983 (United States = 1)

Country	
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Daniel Trefler, *American Economic Review* (December 1995), p. 1037.

If one makes the working assumption that technological differences between countries take a simple multiplicative form—that is, that a given set of inputs produces only δ times as much in China as it does in the United States, where δ is some number less than 1—it is possible to use data on factor trade to estimate the relative efficiency of production in different countries. Table 4-5 shows Trefler's estimates for a sample of countries; they suggest that technological differences are in fact very large.

But in any case, once we conclude that technology varies across countries, why should we assume that it is the same across all industries? Why not suppose instead that different countries have specific areas of expertise: the British are good at software, the Italians at furniture, the Americans at action movies, and so on? In that case, the pattern of international trade might be determined as much by these differing technological capacities as by factor endowments.

Implications of the Tests

The mixed results of tests of the factor-proportions theory place international economists in a difficult position. We saw in Chapter 3 that empirical evidence broadly supports the Ricardian model's prediction that countries will export goods in which their labor is especially productive. Most international economists, however, regard the Ricardian model as too limited to serve as their basic model of international trade. By contrast, the Heckscher-Ohlin model has long occupied a central place in trade theory, because it allows a simultaneous treatment of issues of income distribution and the pattern of trade. So the model that predicts trade best is too limiting for other purposes, while there is by now strong evidence against the pure Heckscher-Ohlin model.

While the Heckscher-Ohlin model has been less successful at explaining the actual patterns of international trade than one might hope, it remains vital for understanding the *effects* of trade, especially its effects on the distribution of income. Indeed, the growth of North-South trade in manufactures—a trade in which the factor intensity of the North's imports is very different from that of its exports—has brought the factor-proportions approach into the center of practical debates over international trade policy.

SUMMARY

1. To understand the role of resources in trade we develop a model in which two goods are produced using two factors of production. The two goods differ in their *factor intensity*, that is, at any given wage-rental ratio, production of one of the goods will use a higher ratio of land to labor than production of the other.

2. As long as a country produces both goods, there is a one-to-one relationship between the relative prices of *goods* and the relative prices of *factors* used to produce the goods. A rise in the relative price of the labor-intensive good will shift the distribution of income in favor of labor, and will do so very strongly: The real wage of labor will rise in terms of both goods, while the real income of landowners will fall in terms of both goods.
3. An increase in the supply of one factor of production expands production possibilities, but in a strongly *biased* way: At unchanged relative goods prices, the output of the good intensive in that factor rises while the output of the other good actually falls.
4. A country that has a large supply of one resource relative to its supply of other resources is *abundant* in that resource. A country will tend to produce relatively more of goods that use its abundant resources intensively. The result is the basic Heckscher-Ohlin theory of trade: Countries tend to export goods that are intensive in the factors with which they are abundantly supplied.
5. Because changes in relative prices of goods have very strong effects on the relative earnings of resources, and because trade changes relative prices, international trade has strong income distribution effects. The owners of a country's abundant factors gain from trade, but the owners of scarce factors lose.
6. In an idealized model international trade would actually lead to equalization of the prices of factors such as labor and capital between countries. In reality, complete *factor- price equalization* is not observed because of wide differences in resources, barriers to trade, and international differences in technology.
7. Trade produces losers as well as winners. But there are still gains from trade in the limited sense that the winners could compensate the losers, and everyone would be better off.
8. Most economists do not regard the effects of international trade on income distribution as a good reason to limit this trade. In its distributional effects, trade is no different from many other forms of economic change, which are not normally regulated. Furthermore, economists would prefer to address the problem of income distribution directly, rather than by interfering with trade flows.
9. Nonetheless, in the actual politics of trade policy income distribution is of crucial importance. This is true in particular because those who lose from trade are usually a much more informed, cohesive, and organized group than those who gain.
10. Empirical evidence is mixed on the Heckscher-Ohlin model, but most researchers do not believe that differences in resources alone can explain the pattern of world trade or world factor prices. Instead, it seems to be necessary to allow for substantial international differences in technology. Nonetheless, the Heckscher-Ohlin model is extremely useful, especially as a way to analyze the effects of trade on income distribution.

KEY TERMS

abundant factor, p. 68
biased expansion of production possibilities, p. 63
budget constraint, p. 66
equalization of factor prices, p. 68
factor abundance, p. 54
factor intensity, p. 54
factor prices, p. 58
factor-proportions theory, p. 54
Heckscher-Ohlin theory, p. 54
Leontief paradox, p. 75
scarce factor, p. 68
specific factor, p. 70

PROBLEMS

myeconlab

1. In the United States where land is cheap, the ratio of land to labor used in cattle raising is higher than that of land used in wheat growing. But in more crowded countries, where land is expensive and labor is cheap, it is common to raise cows by using less land and more labor than Americans use to grow wheat. Can we still say that raising cattle is land-intensive compared with farming wheat? Why or why not?
2. Suppose that at current factor prices cloth is produced using 20 hours of labor for each acre of land, and food is produced using only 5 hours of labor per acre of land.
   a. Suppose that the economy's total resources are 600 hours of labor and 60 acres of land. Use a diagram to determine the allocation of resources.
   b. Now suppose that the labor supply increases first to 800, then 1,000, then 1,200 hours. Using a diagram like Figure 4-9, trace out the changing allocation of resources.
   c. What would happen if the labor supply were to increase even further?
3. "The world's poorest countries cannot find anything to export. There is no resource that is abundant—certainly not capital or land, and in small poor nations not even labor is abundant." Discuss.
4. The U.S. labor movement—which mostly represents blue-collar workers rather than professionals and highly educated workers—has traditionally favored limits on imports from less-affluent countries. Is this a shortsighted policy or a rational one in view of the interests of union members? How does the answer depend on the model of trade?
5. Recently, computer programmers in developing countries such as India have begun doing work formerly done in the United States. This shift has undoubtedly led to substantial pay cuts for some programmers in the United States. Answer the following two questions: How is this possible when the wages of skilled labor are rising in the United States as a whole? What argument would trade economists make against seeing these wage cuts as a reason to block outsourcing of computer programming?
6. Explain why the Leontief paradox and the more recent Bowen, Leamer, and Sveikauskas results reported in the text contradict the factor-proportions theory.
7. In the discussion of empirical results on the Heckscher-Ohlin model, we noted that recent work suggests that the efficiency of factors of production seems to differ internationally. Explain how this would affect the concept of factor-price equalization.

FURTHER READING

Donald Davis and David Weinstein. "An Account of Global Factor Trade." National Bureau of Economic Research Working Paper No. 6785, 1998. The authors review the history of tests of the Heckscher-Ohlin model and propose a modified version—backed by extensive statistical analysis—that allows for technology differences, specialization, and transportation costs.

Alan Deardorff. "Testing Trade Theories and Predicting Trade Flows," in Ronald W. Jones and Peter B. Kenen, eds. *Handbook of International Economics*. Vol. 1. Amsterdam: North-Holland, 1984. A survey of empirical evidence on trade theories, especially the factor-proportions theory.

Gordon Hanson and Ann Harrison. "Trade and Wage Inequality in Mexico." *Industrial and Labor Relations Review* 52 (1999), pp. 271–288. A careful study of the effects of trade on income inequality in our nearest neighbor, showing that factor prices have moved in the opposite direction from what one might have expected from a simple factor-proportions model. The authors also put forward hypotheses about why this may have happened.

Ronald W. Jones. "Factor Proportions and the Heckscher-Ohlin Theorem." *Review of Economic Studies* 24 (1956), pp. 1–10. Extends Samuelson's 1948–1949 analysis (cited below), which focuses primarily on the relationship between trade and income distribution, into an overall model of international trade.

Ronald W. Jones. "The Structure of Simple General Equilibrium Models." *Journal of Political Economy* 73 (1965), pp. 557–572. A restatement of the Heckscher-Ohlin-Samuelson model in terms of elegant algebra.

Ronald W. Jones and J. Peter Neary. "The Positive Theory of International Trade," in Ronald W. Jones and Peter B. Kenen, eds. *Handbook of International Economics*. Vol. 1. Amsterdam: North-Holland, 1984. An up-to-date survey of many trade theories, including the factor-proportions theory.

Bertil Ohlin. *Interregional and International Trade*. Cambridge: Harvard University Press, 1933. The original Ohlin book presenting the factor-proportions view of trade remains interesting—its complex and rich view of trade contrasts with the more rigorous and simplified mathematical models that followed.

Robert Reich. *The Work of Nations*. New York: Basic Books, 1991. An influential tract that argues that the increasing integration of the United States in the world economy is widening the gap between skilled and unskilled workers.

John Romalis. "Factor Proportions and the Structure of Commodity Trade." *The American Economic Review* Vol. 94, No. 1 (March 2004), pp. 67–97. A recent, state-of-the-art demonstration that a modified version of the Heckscher-Ohlin model has a lot of explanatory power.

Paul Samuelson. "International Trade and the Equalisation of Factor Prices." *Economic Journal* 58 (1948), pp. 163–184, and "International Factor Price Equalisation Once Again." *Economic Journal* 59 (1949), pp. 181–196. The most influential formalizer of Ohlin's ideas is Paul Samuelson (again!), whose two *Economic Journal* papers on the subject are classics.

Factor Prices, Goods Prices, and Input Choices

In the main body of this chapter we made two assertions that were true but not carefully derived. First was the assertion, embodied in Figure 4-5, that the ratio of land to labor employed in each industry depended on the wage-rental ratio w/r. Second was the assertion, embodied in Figure 4-6, that there is a one-to-one relationship between relative goods prices P_C/P_F and the wage-rental ratio. This appendix briefly demonstrates both propositions.

Choice of Technique

Figure 4A-1 illustrates again the trade-off between labor and land input in producing one unit of food—the *unit isoquant* for food production shown in curve *II*. It also, however, illustrates a number of *isocost lines*: combinations of land and labor input that cost the same amount.

An isocost line may be constructed as follows: The cost of purchasing a given amount of labor L is wL; the cost of renting a given amount of land T is rT. So if one is able to produce a unit of food using a_{LF} units of labor and a_{TF} units of land, the total cost of producing that unit, K, is

$$K = wa_{LF} + ra_{TF}.$$

A line showing all combinations of a_{LF} and a_{TF} with the same cost has the equation

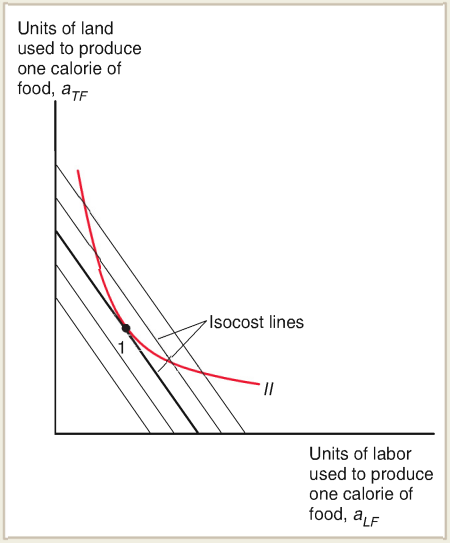
$$a_{TF} = \frac{K}{r} - (w/r)a_{LF}.$$

That is, it is a straight line with a slope of $-w/r$.

Figure 4A-1

Choosing the Optimal Land-Labor Ratio

To minimize costs, a producer must get to the lowest possible isocost line; this means choosing the point on the unit isoquant (the curve *II*) where the slope is equal to minus the wage-rental ratio w/r.



The figure shows a family of such lines, each corresponding to a different level of costs; lines farther from the origin indicate higher total costs. A producer will choose the lowest possible cost given the technological trade-off outlined by curve *II*. Here, this occurs at point 1, where *II* is *tangent* to the isocost line and the slope of *II* equals $-w/r$. (If these results seem reminiscent of the proposition in Figure 3-5, that the economy produces at a point on the production possibility frontier whose slope equals minus P_C/P_F, you are right: The same principle is involved.)

Now compare the choice of land-labor ratio for two different factor price ratios. In Figure 4A-2 we show input choice given a low relative price of labor, $(w/r)^1$, and a high relative price of labor, $(w/r)^2$. In the former case the input choice is at 1, in the latter case at 2. That is, the higher relative price of labor leads to the choice of a higher land-labor ratio, as assumed in Figure 4-5.

Goods Prices and Factor Prices

We now turn to the relationship between goods prices and factor prices. There are several equivalent ways of approaching this problem; here we follow the analysis introduced by Abba Lerner in the 1930s.

Figure 4A-3 shows land and labor inputs into both cloth and food production. In previous figures we have shown the inputs required to produce one unit of a good. In this figure, however, we show the inputs required to produce *one dollar's worth* of each good. (Actually, any dollar amount will do; as long as it is the same for both goods.) Thus the isoquant for cloth, *CC*, shows the possible input combinations for producing $1/P_C$ units of cloth; the isoquant for food, *FF*, shows the possible combinations for producing $1/P_F$ units of food. Notice that as drawn, food production is land-intensive: For any given w/r, food production will always use a higher land-labor ratio than cloth production.

Figure 4A-2

Changing the Wage-Rental Ratio

A rise in w/r shifts the lowest-cost input choice from point 1 to point 2; that is, it leads to the choice of a higher land-labor ratio.

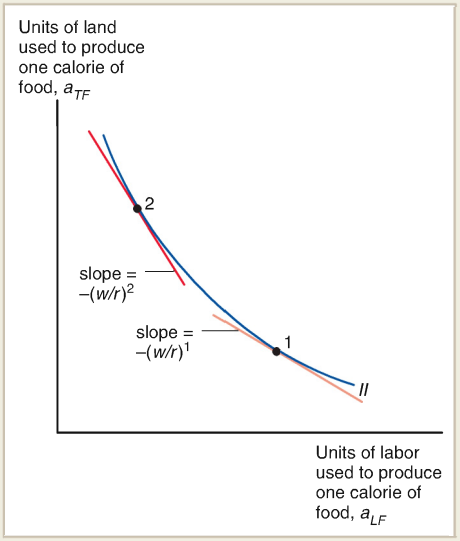
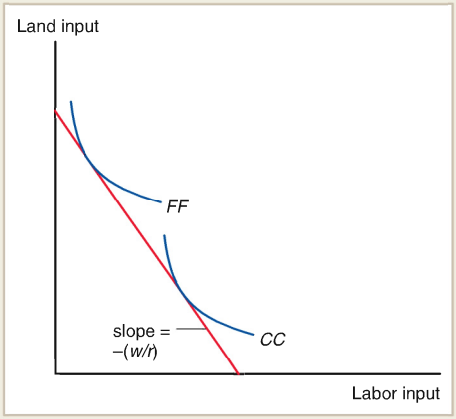


Figure 4A-3

Determining the Wage-Rental Ratio

The two isoquants *CC* and *FF* show the inputs necessary to produce *one dollar's worth* of cloth and food, respectively. Since price must equal the cost of production, the inputs into each good must also cost one dollar; this means that the wage-rental ratio must equal minus the slope of a line tangent to both isoquants.



If the economy produces both goods, then it must be the case that the cost of producing one dollar's worth of each good is, in fact, one dollar. In particular, the cost of producing one dollar's worth of both goods must be the same. This outcome is only possible, however, if the minimum-cost point of production for both goods lie on the *same* isocost line. Thus the slope of the line shown, which is just tangent to both isoquants, must equal (minus) the wage-rental ratio w/r.

Finally, now, consider the effects of a rise in the price of cloth on the wage-rental ratio. If the price of cloth rises, it is necessary to produce fewer yards of cloth in order to have one dollar's worth. Thus the isoquant corresponding to a dollar's worth of cloth shift inward. In Figure 4A-4, the original isoquant is shown as CC^1, the new isoquant as CC^2.

Once again we must draw a line that is just tangent to both isoquants; the slope of that line is minus the wage-rental ratio. It is immediately apparent from the increased steepness of the isocost line (slope $= -(w/r)^2$) that the new w/r is higher than the previous one: A higher relative price of cloth implies a higher wage-rental ratio.

Figure 4A-4

A Rise in the Price of Cloth

If the price of cloth rises, a smaller output is now worth one dollar; so CC^1 is replaced by CC^2. The implied wage-rental ratio must therefore rise from $(w/r)^1$ to $(w/r)^2$