CHAPTER 3

Labor Productivity and Comparative Advantage: The Ricardian Model

Countries engage in international trade for two basic reasons, each of which contributes to their gains from trade. First, countries trade because they are different from each other. Nations, like individuals, can benefit from their differences by reaching an arrangement in which each does the things it does relatively well. Second, countries trade to achieve economies of scale in production. That is, if each country produces only a limited range of goods, it can produce each of these goods at a larger scale and hence more efficiently than if it tried to produce everything. In the real world, patterns of international trade reflect the interaction of both these motives. As a first step toward understanding the causes and effects of trade, however, it is useful to look at simplified models in which only one of these motives is present.

The next three chapters develop tools to help us to understand how differences between countries give rise to trade between them and why this trade is mutually beneficial. The essential concept in this analysis is that of comparative advantage.

Although comparative advantage is a simple concept, experience shows that it is a surprisingly hard concept for many people to understand (or accept). Indeed, Paul Samuelson—the Nobel laureate economist who did much to develop the models of international trade discussed in Chapters 4 and 5—has described comparative advantage as the best example he knows of an economic principle that is undeniably true yet not obvious to intelligent people.

In this chapter we begin with a general introduction to the concept of comparative advantage, then proceed to develop a specific model of how comparative advantage determines the pattern of international trade.

Learning Goals

After reading this chapter, you will be able to:

- Explain how the *Ricardian model,* the most basic model of international trade, works and how it illustrates the principle of *comparative advantage.*

- Demonstrate *gains from trade* and refute common fallacies about international trade.
- Describe the empirical evidence that wages reflect productivity and that trade patterns reflect relative productivity.

The Concept of Comparative Advantage

On Valentine's Day, 1996, which happened to fall less than a week before the crucial February 20 primary in New Hampshire, Republican presidential candidate Patrick Buchanan stopped at a nursery to buy a dozen roses for his wife. He took the occasion to make a speech denouncing the growing imports of flowers into the United States, which he claimed were putting American flower growers out of business. And it is indeed true that a growing share of the market for winter roses in the United States is being supplied by imports flown in from South America. But is that a bad thing?

The case of winter roses offers an excellent example of the reasons why international trade can be beneficial. Consider first how hard it is to supply American sweethearts with fresh roses in February. The flowers must be grown in heated greenhouses, at great expense in terms of energy, capital investment, and other scarce resources. Those resources could have been used to produce other goods. Inevitably, there is a trade-off. In order to produce winter roses, the U.S. economy must produce less of other things, such as computers. Economists use the term **opportunity cost** to describe such trade-offs: The opportunity cost of roses in terms of computers is the number of computers that could have been produced with the resources used to produce a given number of roses.

Suppose, for example, that the United States currently grows 10 million roses for sale on Valentine's Day and that the resources used to grow those roses could have produced 100,000 computers instead. Then the opportunity cost of those 10 million roses is 100,000 computers. (Conversely, if the computers were produced instead, the opportunity cost of those 100,000 computers would be 10 million roses.)

Those 10 million Valentine's Day roses could instead have been grown in South America. It seems extremely likely that the opportunity cost of those roses in terms of computers would be less than it would be in the United States. For one thing, it is a lot easier to grow February roses in the Southern Hemisphere, where it is summer in February rather than winter. Furthermore, South American workers are less efficient than their U.S. counterparts at making sophisticated goods such as computers, which means that a given amount of resources used in computer production yields fewer computers in South America than in the United States. So the trade-off in South America might be something like 10 million winter roses for only 30,000 computers.

This difference in opportunity costs offers the possibility of a mutually beneficial rearrangement of world production. Let the United States stop growing winter roses and devote the resources this frees up to producing computers; meanwhile, let South America grow those roses instead, shifting the necessary resources out of its computer industry. The resulting changes in production would look like Table 3-1.

Look what has happened: The world is producing just as many roses as before, but it is now producing more computers. So this rearrangement of production, with the United States concentrating on computers and South America concentrating on roses, increases the size of the world's economic pie. Because the world as a whole is producing more, it is possible in principle to raise everyone's standard of living.

The reason that international trade produces this increase in world output is that it allows each country to specialize in producing the good in which it has a comparative

TABLE 3-1 Hypothetical Changes in Production

	Million Roses	Thousand Computers
United States	−10	+100
South America	+10	−30
Total	0	+70

advantage. A country has a **comparative advantage** in producing a good if the opportunity cost of producing that good in terms of other goods is lower in that country than it is in other countries.

In this example, South America has a comparative advantage in winter roses and the United States has a comparative advantage in computers. The standard of living can be increased in both places if South America produces roses for the U.S. market, while the United States produces computers for the South American market. We therefore have an essential insight about comparative advantage and international trade: *Trade between two countries can benefit both countries if each country exports the goods in which it has a comparative advantage.*

This is a statement about possibilities, not about what will actually happen. In the real world, there is no central authority deciding which country should produce roses and which should produce computers. Nor is there anyone handing out roses and computers to consumers in both places. Instead, international production and trade is determined in the marketplace where supply and demand rule. Is there any reason to suppose that the potential for mutual gains from trade will be realized? Will the United States and South America actually end up producing the goods in which each has a comparative advantage? Will the trade between them actually make both countries better off?

To answer these questions, we must be much more explicit in our analysis. In this chapter we will develop a model of international trade originally developed by the British economist David Ricardo, who introduced the concept of comparative advantage in the early 19th century.[1] This approach, in which international trade is solely due to international differences in the productivity of labor, is known as the **Ricardian model.**

A One-Factor Economy

To introduce the role of comparative advantage in determining the pattern of international trade, we begin by imagining that we are dealing with an economy—which we call Home—that has only one factor of production. (In Chapter 4 we extend the analysis to models in which there are several factors.) We imagine that only two goods, wine and cheese, are produced. The technology of Home's economy can be summarized by labor productivity in each industry, expressed in terms of the **unit labor requirement,** the number of hours of labor required to produce a pound of cheese or a gallon of wine. For example, it might require 1 hour of labor to produce a pound of cheese, 2 hours to produce a gallon of wine. For future reference, we define a_{LW} and a_{LC} as the unit labor requirements in wine and cheese production, respectively. The economy's total resources are defined as L, the total labor supply.

[1] The classic reference is David Ricardo, *The Principles of Political Economy and Taxation,* first published in 1817.

Production Possibilities

Because any economy has limited resources, there are limits on what it can produce, and there are always trade-offs; to produce more of one good, the economy must sacrifice some production of another good. These trade-offs are illustrated graphically by a **production possibility frontier** (line *PF* in Figure 3-1), which shows the maximum amount of wine that can be produced once the decision has been made to produce any given amount of cheese, and vice versa.

When there is only one factor of production, the production possibility frontier of an economy is simply a straight line. We can derive this line as follows: If Q_W is the economy's production of wine and Q_C its production of cheese, then the labor used in producing wine will be $a_{LW}Q_W$, the labor used in producing cheese $a_{LC}Q_C$. The production possibility frontier is determined by the limits on the economy's resources—in this case, labor. Because the economy's total labor supply is L, the limits on production are defined by the inequality

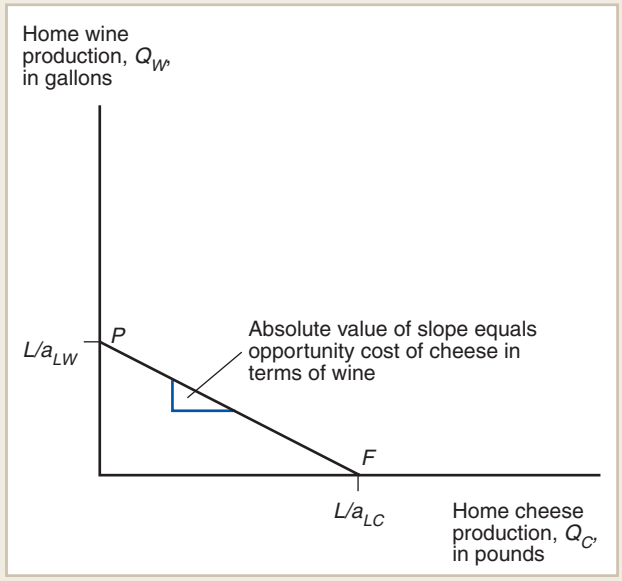
$$a_{LC}Q_C + a_{LW}Q_W \leq L. \tag{3-1}$$

When the production possibility frontier is a straight line, the *opportunity cost* of a pound of cheese in terms of wine is constant. As we saw in the previous section, this opportunity cost is defined as the number of gallons of wine the economy would have to give up in order to produce an extra pound of cheese. In this case, to produce another pound would require a_{LC} person-hours. Each of these person-hours could in turn have been used to produce $1/a_{LW}$ gallons of wine. Thus the opportunity cost of cheese in terms of wine is a_{LC}/a_{LW}. For example, if it takes one person-hour to make a pound of cheese and two hours to produce a gallon of wine, the opportunity cost of cheese in terms of wine is one-half. As Figure 3-1 shows, this opportunity cost is equal to the absolute value of the slope of the production possibility frontier.

Figure 3-1

Home's Production Possibility Frontier

The line *PF* shows the maximum amount of cheese Home can produce given any production of wine, and vice versa.



Relative Prices and Supply

The production possibility frontier illustrates the different mixes of goods the economy *can* produce. To determine what the economy will actually produce, however, we need to look at prices. Specifically, we need to know the relative price of the economy's two goods, that is, the price of one good in terms of the other.

In a competitive economy, supply decisions are determined by the attempts of individuals to maximize their earnings. In our simplified economy, since labor is the only factor of production, the supply of cheese and wine will be determined by the movement of labor to whichever sector pays the higher wage.

Let P_C and P_W be the prices of cheese and wine, respectively. It takes a_{LC} person-hours to produce a pound of cheese; since there are no profits in our one-factor model, the hourly wage in the cheese sector will equal the value of what a worker can produce in an hour, P_C/a_{LC}. Since it takes a_{LW} person-hours to produce a gallon of wine, the hourly wage rate in the wine sector will be P_W/a_{LW}. Wages in the cheese sector will be higher if $P_C/P_W > a_{LC}/a_{LW}$; wages in the wine sector will be higher if $P_C/P_W < a_{LC}/a_{LW}$. Because everyone will want to work in whichever industry offers the higher wage, the economy will specialize in the production of cheese if $P_C/P_W > a_{LC}/a_{LW}$; it will specialize in the production of wine if $P_C/P_W < a_{LC}/a_{LW}$. Only when P_C/P_W is equal to a_{LC}/a_{LW} will both goods be produced.

What is the significance of the number a_{LC}/a_{LW}? We saw in the previous section that it is the opportunity cost of cheese in terms of wine. We have therefore just derived a crucial proposition about the relationship between prices and production: *The economy will specialize in the production of cheese if the relative price of cheese exceeds its opportunity cost; it will specialize in the production of wine if the relative price of cheese is less than its opportunity cost.*

In the absence of international trade, Home would have to produce both goods for itself. But it will produce both goods only if the relative price of cheese is just equal to its opportunity cost. Since opportunity cost equals the ratio of unit labor requirements in cheese and wine, we can summarize the determination of prices in the absence of international trade with a simple labor theory of value: *In the absence of international trade, the relative prices of goods are equal to their relative unit labor requirements.*

Trade in a One-Factor World

To describe the pattern and effects of trade between two countries when each country has only one factor of production is simple. Yet the implications of this analysis can be surprising. Indeed to those who have not thought about international trade many of these implications seem to conflict with common sense. Even this simplest of trade models can offer some important guidance on real-world issues, such as what constitutes fair international competition and fair international exchange.

Before we get to these issues, however, let us get the model stated. Suppose that there are two countries. One of them we again call Home and the other we call Foreign. Each of these countries has one factor of production (labor) and can produce two goods, wine and cheese. As before, we denote Home's labor force by L and Home's unit labor requirements in wine and cheese production by a_{LW} and a_{LC}, respectively. For Foreign we will use a convenient notation throughout this book: When we refer to some aspect of Foreign, we will use the same symbol that we use for Home, but with an asterisk. Thus Foreign's labor force will be denoted by L^*, Foreign's unit labor requirements in wine and cheese will be denoted by a^*_{LW} and a^*_{LC}, respectively, and so on.

In general, the unit labor requirements can follow any pattern. For example, Home could be less productive than Foreign in wine but more productive in cheese, or vice versa. For the moment, we make only one arbitrary assumption: that

$$a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW} \tag{3-2}$$

or, equivalently, that

$$a_{LC}/a^*_{LC} < a_{LW}/a^*_{LW} \tag{3-3}$$

In words, we are assuming that the ratio of the labor required to produce a pound of cheese to that required to produce a gallon of wine is lower in Home than it is in Foreign. More briefly still, we are saying that Home's relative productivity in cheese is higher than it is in wine.

But remember that the ratio of unit labor requirements is equal to the opportunity cost of cheese in terms of wine; and remember also that we defined comparative advantage precisely in terms of such opportunity costs. So the assumption about relative productivities embodied in equations (3-2) and (3-3) amounts to saying that *Home has a comparative advantage in cheese.*

One point should be noted immediately: The condition under which Home has this comparative advantage involves all four unit labor requirements, not just two. You might think that to determine who will produce cheese, all you need to do is compare the two countries' unit labor requirements in cheese production, a_{LC} and a^*_{LC}. If $a_{LC} < a^*_{LC}$, Home labor is more efficient than Foreign in producing cheese. When one country can produce a unit of a good with less labor than another country, we say that the first country has an **absolute advantage** in producing that good. In our example, Home has an absolute advantage in producing cheese.

What we will see in a moment, however, is that we cannot determine the pattern of trade from absolute advantage alone. One of the most important sources of error in discussing international trade is to confuse comparative advantage with absolute advantage.

Given the labor forces and the unit labor requirements in the two countries, we can draw the production possibility frontier for each country. We have already done this for Home, by drawing *PF* in Figure 3-1. The production possibility frontier for Foreign is shown as PF^* in Figure 3-2. Since the slope of the production possibility frontier equals the opportunity cost of cheese in terms of wine, Foreign's frontier is steeper than Home's.

In the absence of trade, the relative prices of cheese and wine in each country would be determined by the relative unit labor requirements. Thus in Home the relative price of cheese would be a_{LC}/a_{LW}; in Foreign it would be a^*_{LC}/a^*_{LW}.

Once we allow for the possibility of international trade, however, prices will no longer be determined purely by domestic considerations. If the relative price of cheese is higher in Foreign than in Home, it will be profitable to ship cheese from Home to Foreign and to ship wine from Foreign to Home. This cannot go on indefinitely, however. Eventually Home will export enough cheese and Foreign enough wine to equalize the relative price. But what determines the level at which that price settles?

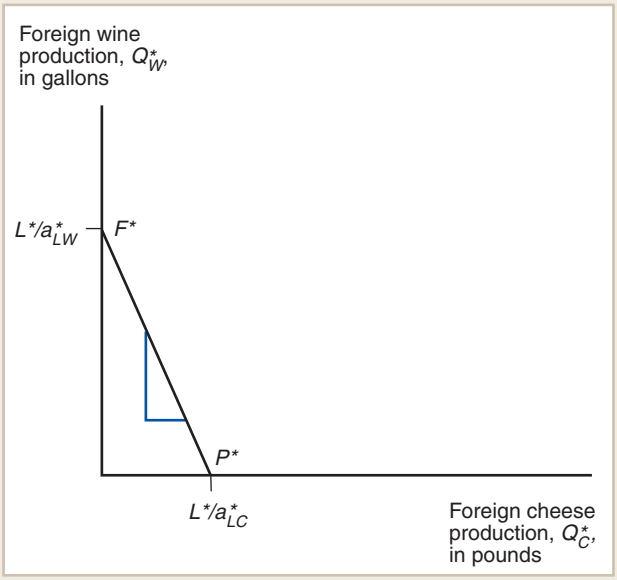
Determining the Relative Price After Trade

Prices of internationally traded goods, like other prices, are determined by supply and demand. In discussing comparative advantage, however, we must apply supply-and-demand analysis carefully. In some contexts, such as some of the trade policy analysis in Chapters 8

Figure 3-2

Foreign's Production Possibility Frontier

Because Foreign's relative unit labor requirement in cheese is higher than Home's (it needs to give up many more units of wine to produce one more unit of cheese), its production possibility frontier is steeper.



through 11, it is acceptable to focus only on supply and demand in a single market. In assessing the effects of U.S. import quotas on sugar, for example, it is reasonable to use **partial equilibrium analysis,** that is, to study a single market, the sugar market. When we study comparative advantage, however, it is crucial to keep track of the relationships between markets (in our example the markets for wine and cheese). Since Home exports cheese only in return for imports of wine, and Foreign exports wine in return for cheese, it can be misleading to look at the cheese and wine markets in isolation. What is needed is **general equilibrium analysis,** which takes account of the linkages between the two markets.

One useful way to keep track of two markets at once is to focus not just on the quantities of cheese and wine supplied and demanded but also on the *relative* supply and demand, that is, on the number of pounds of cheese supplied or demanded divided by the number of gallons of wine supplied or demanded.

Figure 3-3 shows world supply and demand for cheese relative to wine as functions of the price of cheese relative to that of wine. The **relative demand curve** is indicated by *RD*; the **relative supply curve** is indicated by *RS*. World general equilibrium requires that relative supply equal relative demand, and thus the world relative price is determined by the intersection of *RD* and *RS*.

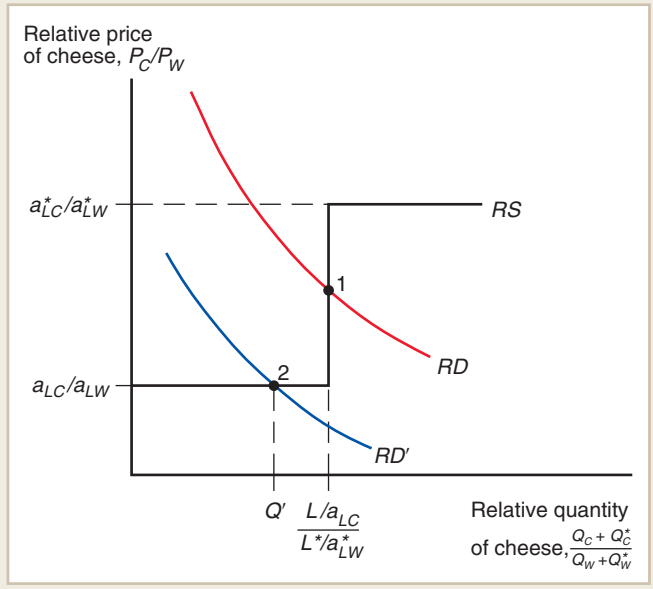
The striking feature of Figure 3-3 is the funny shape of the relative supply curve *RS:* a "step" with flat sections linked by a vertical section. Once we understand the derivation of the *RS* curve, we will be almost home-free in understanding the whole model.

First, as drawn, the *RS* curve shows that there is no supply of cheese if the world price drops below a_{LC}/a_{LW}. To see why, recall that we showed that Home will specialize in the production of wine whenever $P_C/P_W < a_{LC}/a_{LW}$. Similarly, Foreign will specialize in wine production whenever $P_C/P_W < a^*_{LC}/a^*_{LW}$. At the start of our discussion of equation (3-2) we made the assumption that $a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$. So at relative prices of cheese below a_{LC}/a_{LW}, there will be no world cheese production.

Figure 3-3

World Relative Supply and Demand

The *RD* and *RD′*; cuves show that the demand for cheese relative to wine is a decreasing function of the price of cheese relative to that of wine, while the *RS* curve shows that the supply of cheese relative to wine is an increasing function of the same relative price.



Next, when the relative price of cheese, P_C/P_W, is exactly a_{LC}/a_{LW}, we know that workers in Home can earn exactly the same amount making either cheese or wine. So Home will be willing to supply any relative amount of the two goods, producing a flat section to the supply curve.

We have already seen that if P_C/P_W is above a_{LC}/a_{LW}, Home will specialize in the production of cheese. As long as $P_C/P_W < a^*_{LC}/a^*_{LW}$, however, Foreign will continue to specialize in producing wine. When Home specializes in cheese production, it produces L/a_{LC} pounds. Similarly, when Foreign specializes in wine, it produces L^*/a^*_{LW} gallons. So for any relative price of cheese between a_{LC}/a_{LW} and a^*_{LC}/a^*_{LW} the relative supply of cheese is

$$(L/a_{LC})/(L^*/a^*_{LW}). \tag{3-4}$$

At $P_C/P_W = a^*_{LC}/a^*_{LW}$, we know that Foreign workers are indifferent between producing cheese and wine. Thus here we again have a flat section of the supply curve.

Finally, for $P_C/P_W > a^*_{LC}/a^*_{LW}$, both Home and Foreign will specialize in cheese production. There will be no wine production, so that the relative supply of cheese will become infinite.

The relative demand curve *RD* does not require such exhaustive analysis. The downward slope of *RD* reflects substitution effects. As the relative price of cheese rises, consumers will tend to purchase less cheese and more wine, so the relative demand for cheese falls.

The equilibrium relative price of cheese is determined by the intersection of the relative supply and relative demand curves. Figure 3-3 shows a relative demand curve *RD* that intersects the *RS* curve at point 1, where the relative price of cheese is between the two countries' pretrade prices. In this case, each country specializes in the production of the good in which it has a comparative advantage: Home produces only cheese, Foreign only wine.

This is not, however, the only possible outcome. If the relevant *RD* curve were *RD′*, for example, relative supply and relative demand would intersect on one of the horizontal

Comparative Advantage in Practice: The Case of Babe Ruth

Everyone knows that Babe Ruth was the greatest slugger in the history of baseball. Only true fans of the sport know, however, that Ruth also was one of the greatest *pitchers* of all time. Because Ruth stopped pitching after 1918 and played outfield during all the time he set his famous batting records, most people don't realize that he even could pitch. What explains Ruth's lopsided reputation as a batter? The answer is provided by the principle of comparative advantage.

As a player with the Boston Red Sox early in his career, Ruth certainly had an *absolute* advantage in pitching. According to historian Geoffrey C. Ward and filmmaker Ken Burns:

> In the Red Sox's greatest years, he was their greatest player, the best left-handed pitcher in the American League, winning 89 games in six seasons. In 1916 he got his first chance to pitch in the World Series and made the most of it. After giving up a run in the first, he drove in the tying run himself, after which he held the Brooklyn Dodgers scoreless for eleven innings until his teammates could score the winning run. . . . In the 1918 series, he would show that he could still handle them, stretching his series record to $29^2/_3$ scoreless innings, a mark that stood for forty-three years.*

The Babe's World Series pitching record was broken by New York Yankee Whitey Ford in the same year, 1961, that his teammate Roger Maris shattered Ruth's 1927 record of 60 home runs in a single season.

Although Ruth had an absolute advantage in pitching, his skill as a batter relative to his teammates' abilities was even greater: His *comparative* advantage was at the plate. As a pitcher, however, Ruth had to rest his arm between appearances and therefore could not bat in every game. To exploit Ruth's comparative advantage, the Red Sox moved him to center field in 1919 so that he could bat more frequently.

The payoff to having Ruth specialize in batting was huge. In 1919, he hit 29 home runs, "more than any player had ever hit in a single season," according to Ward and Burns. The Yankees kept Ruth in the outfield (and at the plate) after they acquired him in 1920. They knew a good thing when they saw it. That year, Ruth hit 54 home runs, set a slugging record (bases divided by at bats) that remains untouched to this day, and turned the Yankees into baseball's most renowned franchise.

*See Geoffrey C. Ward and Ken Burns, *Baseball: An Illustrated History* (New York: Knopf, 1994), p. 155. Ruth's career preceded the designated hitter rule, so American League pitchers, like National League pitchers today, took their turns at bat.

sections of *RS*. At point 2 the world relative price of cheese after trade is a_{LC}/a_{LW}, the same as the opportunity cost of cheese in terms of wine in Home.

What is the significance of this outcome? If the relative price of cheese is equal to its opportunity cost in Home, the Home economy need not specialize in producing either cheese or wine. In fact, at point 2 Home must be producing both some wine and some cheese; we can infer this from the fact that the relative supply of cheese (point Q' on the horizontal axis) is less than it would be if Home were in fact completely specialized. Since P_C/P_W is below the opportunity cost of cheese in terms of wine in Foreign, however, Foreign does specialize completely in producing wine. It therefore remains true that if a country does specialize, it will do so in the good in which it has a comparative advantage.

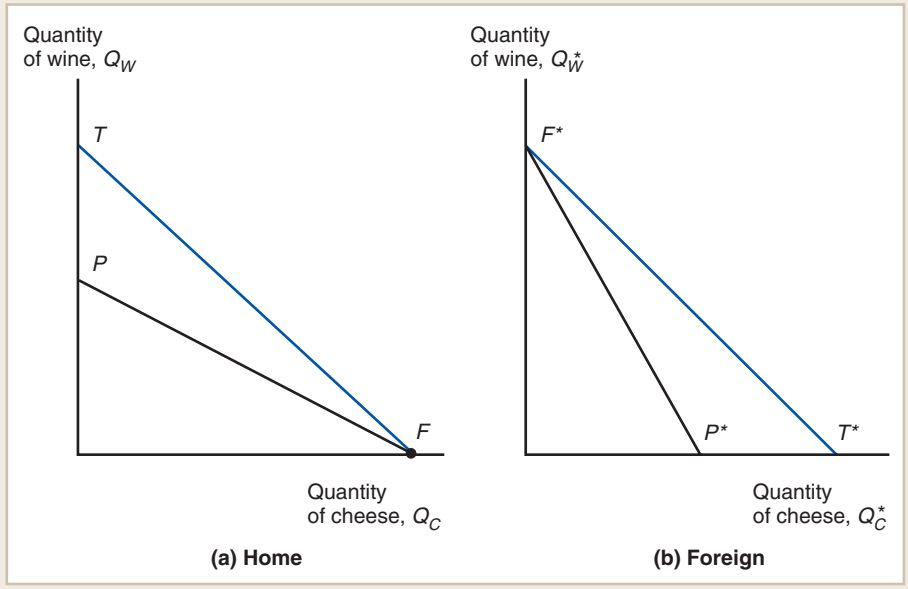


Figure 3-4

Trade Expands Consumption Possibilities

International trade allows Home and Foreign to consume anywhere within the colored lines, which lie outside the countries' production frontiers.

Let us for the moment leave aside the possibility that one of the two countries does not completely specialize. Except in this case, the normal result of trade is that the price of a traded good (e.g., cheese) relative to that of another good (wine) ends up somewhere in between its pretrade levels in the two countries.

The effect of this convergence in relative prices is that each country specializes in the production of that good in which it has the relatively lower unit labor requirement. The rise in the relative price of cheese in Home will lead Home to specialize in the production of cheese, producing at point F in Figure 3-4a. The fall in the relative price of cheese in Foreign will lead Foreign to specialize in the production of wine, producing at point F^* in Figure 3-4b.

The Gains from Trade

We have now seen that countries whose relative labor productivities differ across industries will specialize in the production of different goods. We next show that both countries derive **gains from trade** from this specialization. This mutual gain can be demonstrated in two alternative ways.

The first way to show that specialization and trade are beneficial is to think of trade as an indirect method of production. Home could produce wine directly, but trade with Foreign allows it to "produce" wine by producing cheese and then trading the cheese for wine. This indirect method of "producing" a gallon of wine is a more efficient method than direct production. Consider two alternative ways of using an hour of labor. On one side, Home could use the hour directly to produce $1/a_{LW}$ gallons of wine. Alternatively, Home could use the hour to produce $1/a_{LC}$ pounds of cheese. This cheese could then be traded for wine, with each pound trading for P_C/P_W gallons, so our original hour of labor yields

$(1/a_{LC})\,(P_C/P_W)$ gallons of wine. This will be more wine than the hour could have produced directly as long as

$$(1/a_{LC})\,(P_C/P_W) > 1/a_{LW}, \tag{3-5}$$

or

$$P_C/P_W > a_{LC}/a_{LW}.$$

But we just saw that in international equilibrium, if neither country produces both goods, we must have $P_C/P_W > a_{LC}/a_{LW}$. This shows that Home can "produce" wine more efficiently by making cheese and trading it than by producing wine directly for itself. Similarly, Foreign can "produce" cheese more efficiently by making wine and trading it. This is one way of seeing that both countries gain.

Another way to see the mutual gains from trade is to examine how trade affects each country's possibilities for consumption. In the absence of trade, consumption possibilities are the same as production possibilities (the solid lines PF and P^*F^* in Figure 3-4). Once trade is allowed, however, each economy can consume a different mix of cheese and wine from the mix it produces. Home's consumption possibilities are indicated by the colored line TF in Figure 3-4a, while Foreign's consumption possibilities are indicated by T^*F^* in Figure 3-4b. In each case, trade has enlarged the range of choice, and therefore it must make residents of each country better off.

A Numerical Example

In this section, we use a numerical example to solidify our understanding of two crucial points:

> When two countries specialize in producing the goods in which they have a comparative advantage, both countries gain from trade.
>
> *Comparative* advantage must not be confused with *absolute* advantage; it is comparative, not absolute, advantage that determines who will and should produce a good.

Suppose, then, that Home and Foreign have the unit labor requirements illustrated in Table 3-2.

A striking feature of this table is that Home has lower unit labor requirements, that is, it has higher labor productivity, in both industries. Let us leave this observation for a moment, however, and focus on the pattern of trade.

The first thing we need to do is determine the relative price of cheese P_C/P_W. While the actual relative price depends on demand, we know that it must lie between the opportunity cost of cheese in the two countries. In Home, we have $a_{LC} = 1, a_{LW} = 2$; so the opportunity cost of cheese in terms of wine in Home is $a_{LC}/a_{LW} = 1/2$. In Foreign, $a^*_{LC} = 6$, $a^*_{LW} = 3$; so the opportunity cost of cheese is 2. In world equilibrium, the relative price of cheese must

TABLE 3-2 Unit Labor Requirements

	Cheese	Wine
Home	$a_{LC} = 1$ hour per pound	$a_{LW} = 2$ hours per gallon
Foreign	$a^*_{LC} = 6$ hours per pound	$a^*_{LW} = 3$ hours per gallon

lie between these values. In our example we assume that in world equilibrium a pound of cheese trades for a gallon of wine on world markets so that $P_C/P_W = 1$.

If a pound of cheese sells for the same price as a gallon of wine, both countries will specialize. It takes only half as many person-hours in Home to produce a pound of cheese as it takes to produce a gallon of wine (1 versus 2); so Home workers can earn more by producing cheese, and Home will specialize in cheese production. Conversely, it takes twice as many Foreign person-hours to produce a pound of cheese as it takes to produce a gallon of wine (6 versus 3), so Foreign workers can earn more by producing wine, and Foreign will specialize in wine production.

Let us confirm that this pattern of specialization produces gains from trade. First, we want to show that Home can "produce" wine more efficiently by making cheese and trading it for wine than by direct production. In direct production, an hour of Home labor produces only $^1/_2$ gallon of wine. The same hour could be used to produce 1 pound of cheese, which can then be traded for 1 gallon of wine. Clearly, Home does gain from trade. Similarly, Foreign could use 1 hour of labor to produce $^1/_6$ pound of cheese; if, however, it uses the hour to produce $^1/_3$ gallon of wine, it could then trade the $^1/_3$ gallon of wine for $^1/_3$ pound of cheese. This is twice as much as the $^1/_6$ pound of cheese it gets using the hour to produce the cheese directly. In this example, each country can use labor twice as efficiently to trade for what it needs instead of producing its imports for itself.

Relative Wages

Political discussions of international trade often focus on comparisons of wage rates in different countries. For example, opponents of trade between the United States and Mexico often emphasize the point that workers in Mexico are paid only about $2 per hour, compared with more than $15 per hour for the typical worker in the United States. Our discussion of international trade up to this point has not explicitly compared wages in the two countries, but it is possible in the context of this numerical example to determine how the wage rates in the two countries compare.

In this example, once the countries have specialized, all Home workers are employed producing cheese. Since it takes 1 hour of labor to produce 1 pound of cheese, workers in Home earn the value of 1 pound of cheese per hour of their labor. Similarly, Foreign workers produce only wine; since it takes 3 hours for them to produce each gallon, they earn the value of $^1/_3$ of a gallon of wine per hour.

To convert these numbers into dollar figures, we need to know the prices of cheese and wine. Suppose that a pound of cheese and a gallon of wine both sell for $12; then Home workers will earn $12 per hour, while Foreign workers will earn $4 per hour. The **relative wage** of a country's workers is the amount they are paid per hour, compared with the amount workers in another country are paid per hour. The relative wage of Home workers will therefore be 3.

Clearly, this relative wage does not depend on whether the price of a pound of cheese is $12 or $20, as long as a gallon of wine sells for the same price. As long as the relative price of cheese—the price of a pound of cheese divided by the price of a gallon of wine—is 1, the wage of Home workers will be three times that of Foreign workers.

Notice that this wage rate lies between the ratios of the two countries' productivities in the two industries. Home is six times as productive as Foreign in cheese, but only one-and-a-half times as productive in wine, and it ends up with a wage rate three times as high as Foreign's. It is precisely because the relative wage is between the relative productivities that each country ends up with a *cost* advantage in one good. Because of

The Losses from Nontrade

Our discussion of the gains from trade was considered a "thought experiment" in which we compared two situations: one in which countries do not trade at all, another in which they have free trade. It's a hypothetical case that helps us to understand the principles of international economics, but it does not have much to do with actual events. After all, countries don't suddenly go from no trade to free trade or vice versa. Or do they?

As economic historian Douglas Irwin* has pointed out, in the early history of the United States the country actually did carry out something very close to the thought experiment of moving from free trade to no trade. The historical context was as follows: At the time Britain and France were engaged in a massive military struggle, the Napoleonic Wars. Both countries endeavored to bring economic pressures to bear: France tried to keep European countries from trading with Britain, while Britain imposed a blockade on France. The young United States was neutral in the conflict but suffered considerably. In particular, the British navy often seized U.S. merchant ships and, on occasion, forcibly recruited their crews into its service.

In an effort to pressure Britain into ceasing these practices, President Thomas Jefferson declared a complete ban on overseas shipping. This embargo would deprive both the United States and Britain of the gains from trade, but Jefferson hoped that Britain would be hurt more and would agree to stop its depredations.

Irwin presents evidence suggesting that the embargo was quite effective: Although some smuggling took place, trade between the United States and the rest of the world was drastically reduced. In effect, the United States gave up international trade for a while.

The costs were substantial. Although quite a lot of guesswork is involved, Irwin suggests that real income in the United States may have fallen by about 8 percent as a result of the embargo. When you bear in mind that in the early 19th century only a fraction of output could be traded—transport costs were still too high, for example, to allow large-scale shipments of commodities like wheat across the Atlantic—that's a pretty substantial sum.

Unfortunately for Jefferson's plan, Britain did not seem to feel equal pain and showed no inclination to give in to U.S. demands. Fourteen months after the embargo was imposed, it was repealed. Britain continued its practices of seizing American cargoes and sailors; three years later the two countries went to war.

*Douglas Irwin, "The Welfare Cost of Autarky: Evidence from the Jeffersonian Trade Embargo, 1807–1809," National Bureau of Economic Research Working Paper No. 8692, December 2001.

its lower wage rate, Foreign has a cost advantage in wine, even though it has lower productivity. Home has a cost advantage in cheese, despite its higher wage rate, because the higher wage is more than offset by its higher productivity.

We have now developed the simplest of all models of international trade. Even though the Ricardian one-factor model is far too simple to be a complete analysis of either the causes or the effects of international trade, a focus on relative labor productivities can be a very useful tool for thinking about international trade. In particular, the simple one-factor model is a good way to deal with several common misconceptions about the meaning of comparative advantage and the nature of the gains from free trade. These misconceptions appear so frequently in public debate about international economic policy, and even in statements by those who regard themselves as experts, that in

the next section we take time out to discuss some of the most common misunderstandings about comparative advantage in light of our model.

Misconceptions About Comparative Advantage

There is no shortage of muddled ideas in economics. Politicians, business leaders, and even economists frequently make statements that do not stand up to careful economic analysis. For some reason this seems to be especially true in international economics. Open the business section of any Sunday newspaper or weekly news magazine and you will probably find at least one article that makes foolish statements about international trade. Three misconceptions in particular have proved highly persistent, and our simple model of comparative advantage can be used to see why they are incorrect.

Productivity and Competitiveness

Myth 1: Free trade is beneficial only if your country is strong enough to stand up to foreign competition. This argument seems extremely plausible to many people. For example, a well-known historian recently criticized the case for free trade by asserting that it may fail to hold in reality: "What if there is nothing you can produce more cheaply or efficiently than anywhere else, except by constantly cutting labor costs?" he worried.[2]

The problem with this commentator's view is that he failed to understand the essential point of Ricardo's model, that gains from trade depend on *comparative* rather than *absolute* advantage. He is concerned that your country may turn out not to have anything it produces more efficiently than anyone else—that is, that you may not have an absolute advantage in anything. Yet why is that such a terrible thing? In our simple numerical example of trade, Home has lower unit labor requirements and hence higher productivity in both the cheese and wine sectors. Yet, as we saw, both countries gain from trade.

It is always tempting to suppose that the ability to export a good depends on your country having an absolute advantage in productivity. But an absolute productivity advantage over other countries in producing a good is neither a necessary nor a sufficient condition for having a *comparative* advantage in that good. In our one-factor model, the reason absolute productivity advantage in an industry is neither necessary nor sufficient to yield competitive advantage is clear: *The competitive advantage of an industry depends not only on its productivity relative to the foreign industry, but also on the domestic wage rate relative to the foreign wage rate.* A country's wage rate, in turn, depends on relative productivity in its other industries. In our numerical example, Foreign is less efficient than Home in the manufacture of wine, but at even a greater relative productivity disadvantage in cheese. Because of its overall lower productivity, Foreign must pay lower wages than Home, sufficiently lower that it ends up with lower costs in wine production. Similarly, in the real world, Portugal has low productivity in producing, say, clothing as compared with the United States, but because Portugal's productivity disadvantage is even greater in other industries, it pays low enough wages to have a comparative advantage in clothing all the same.

But isn't a competitive advantage based on low wages somehow unfair? Many people think so; their beliefs are summarized by our second misconception.

[2] Paul Kennedy, "The Threat of Modernization," *New Perspectives Quarterly* (Winter 1995), pp. 31–33.

The Pauper Labor Argument

Myth 2: Foreign competition is unfair and hurts other countries when it is based on low wages. This argument, sometimes referred to as the **pauper labor argument,** is a particular favorite of labor unions seeking protection from foreign competition. People who adhere to this belief argue that industries should not have to cope with foreign industries that are less efficient but pay lower wages. This view is widespread and has acquired considerable political influence. In 1993, Ross Perot, a self-made billionaire and former presidential candidate, warned that free trade between the United States and Mexico, with its much lower wages, would lead to a "giant sucking sound" as U.S. industry moved south. In the same year, Sir James Goldsmith, another self-made billionaire who was an influential member of the European Parliament, offered similar if less picturesquely expressed views in his book *The Trap,* which became a best seller in France.

Again, our simple example reveals the fallacy of this argument. In the example, Home is more productive than Foreign in both industries, and Foreign's lower cost of wine production is entirely due to its much lower wage rate. Foreign's lower wage rate is, however, irrelevant to the question of whether Home gains from trade. Whether the lower cost of wine produced in Foreign is due to high productivity or low wages does not matter. All that matters to Home is that it is cheaper *in terms of its own labor* for Home to produce cheese and trade it for wine than to produce wine for itself.

This is fine for Home, but what about Foreign? Isn't there something wrong with basing one's exports on low wages? Certainly it is not an attractive position to be in, but the idea that trade is good only if you receive high wages is our final fallacy.

Exploitation

Myth 3: Trade exploits a country and makes it worse off if its workers receive much lower wages than workers in other nations. This argument is often expressed in emotional terms. For example, one columnist contrasted the $2 million income of the chief executive officer of the clothing chain The Gap with the $0.56 per hour paid to the Central American workers who produce some of its merchandise.[3] It can seem hard-hearted to try to justify the terrifyingly low wages paid to many of the world's workers.

If one is asking about the desirability of free trade, however, the point is not to ask whether low-wage workers deserve to be paid more but to ask whether they and their country are worse off exporting goods based on low wages than they would be if they refused to enter into such demeaning trade. And in asking this question one must also ask, *What is the alternative?*

Abstract though it is, our numerical example makes the point that one cannot declare that a low wage represents exploitation unless one knows what the alternative is. In that example, Foreign workers are paid much less than Home workers, and one could easily imagine a columnist writing angrily about their exploitation. Yet if Foreign refused to let itself be "exploited" by refusing to trade with Home (or by insisting on much higher wages in its export sector, which would have the same effect), real wages would be even lower: The purchasing power of a worker's hourly wage would fall from $^1/_3$ to $^1/_6$ pound of cheese.

The columnist who pointed out the contrast in incomes between the executive at The Gap and the workers who make its clothes was angry at the poverty of Central American

[3] Bob Herbert, "Sweatshop Beneficiaries: How to Get Rich on 56 Cents an Hour," *New York Times* (July 24, 1995), p. A13.

Do Wages Reflect Productivity?

In the numerical example that we use to puncture common misconceptions about comparative advantage, we assume that the relative wage of the two countries reflects their relative productivity—specifically, that the ratio of Home to Foreign wages is in a range that gives each country a cost advantage in one of the two goods. This is a necessary implication of our theoretical model. But many people are unconvinced by that model. In particular, rapid increases in productivity in "emerging" economies like China have worried some Western observers, who argue that these countries will continue to pay low wages even as their productivity increases—putting high-wage countries at a cost disadvantage—and dismiss the contrary predictions of orthodox economists as unrealistic theoretical speculation. Leaving aside the logic of this position, what is the evidence?

The answer is that in the real world, national wage rates do, in fact, reflect differences in productivity. The accompanying figure compares estimates of productivity with estimates of wage rates for a selection of countries in 2000. Both measures are expressed as percentages of U.S. levels. Our estimate of productivity is GDP per worker measured in U.S. dollars; as we'll see in the second half of this book, that basis should indicate productivity in the production of traded goods. Wage rates are measured by wages in manufacturing, where available; data for China and India are wage rates paid by none other than McDonald's, an often useful data source.

If wages were exactly proportional to productivity, all the points in this chart would lie along the indicated 45-degree line. In reality, the fit isn't bad. In particular, low wage rates in China and India reflect low productivity.

The low estimate of overall Chinese productivity may seem surprising, given all the stories one hears about Americans who find themselves competing with Chinese exports. The Chinese workers producing those exports don't seem to have extremely low productivity. But remember what the theory of comparative advantage says: Countries export the goods in which they have relatively high productivity. So it's only to be expected that China's overall relative productivity is far below the level in its export industries.

The figure on the next page tells us that the orthodox economists' view that national wage rates reflect national productivity is, in fact, verified by the data at a point in time. It's also true that in the past, rising relative productivity has led to rising wages. Consider, for example, the case of South Korea. In 2000, South Korea's labor productivity was about 35 percent of the U.S. level, and its wage rate was about 38 percent of the U.S. level. But it wasn't always that way: In the not too distant past, South Korea was a low-productivity, low-wage economy.

workers. But to deny them the opportunity to export and trade might well be to condemn them to even deeper poverty.

Comparative Advantage with Many Goods

In our discussion so far we have relied on a model in which only two goods are produced and consumed. This simplified analysis allows us to capture many essential points about comparative advantage and trade and, as we saw in the last section, gives us a surprising amount of mileage as a tool for discussing policy issues. To move closer to reality, however, it is necessary to understand how comparative advantage functions in a model with a larger number of goods.

Setting Up the Model

Again, imagine a world of two countries, Home and Foreign. As before, each country has only one factor of production, labor. Each of these countries will now, however, be

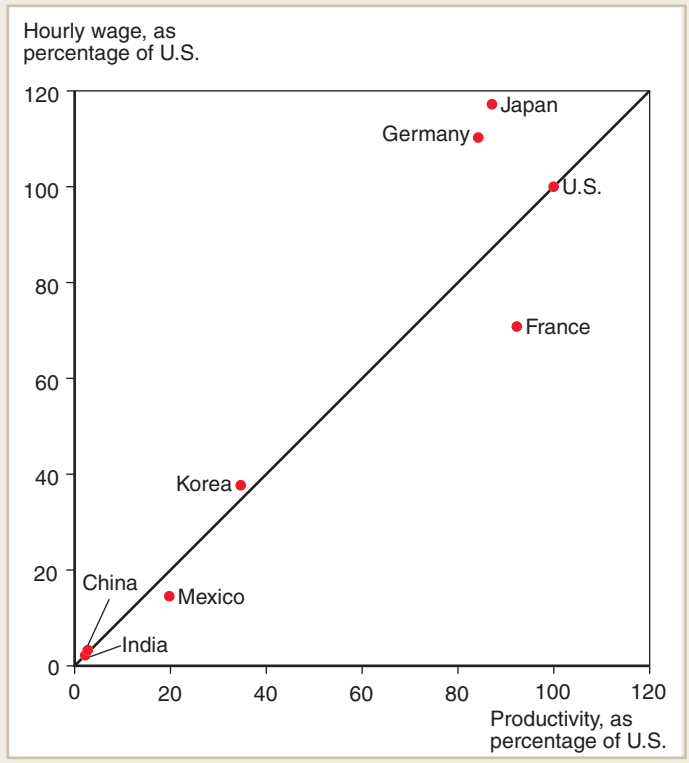
As recently as 1975, South Korean wages were only 5 percent those of the United States. But when South Korean productivity rose, so did its wage rate.

In short, the evidence strongly supports the view, based on economic models, that productivity increases are reflected in wage increases.

Productivity and Wages

A country's wage rate is roughly proportional to the country's productivity.

Source: International Labor Organization, World Bank, Bureau of Labor Statistics, and Orley Ashenfelter and Stepan Jurajda, "Cross-country Comparisons of Wage Rates," working paper, Princeton University.



assumed to consume and to be able to produce a large number of goods—say, N different goods altogether. We assign each of the goods a number from 1 to N.

The technology of each country can be described by its unit labor requirement for each good, that is, the number of hours of labor it takes to produce one unit of each. We label Home's unit labor requirement for a particular good as a_{Li}, where i is the number we have assigned to that good. If cheese is now good number 7, a_{L7} will mean the unit labor requirement in cheese production. Following our usual rule, we label the corresponding Foreign unit labor requirements a^*_{Li}.

To analyze trade, we next pull one more trick. For any good we can calculate a_{Li}/a^*_{Li}, the ratio of Home's unit labor requirement to Foreign's. The trick is to relabel the goods so that the lower the number, the lower this ratio. That is, we reshuffle the order in which we number goods in such a way that

$$a_{L1}/a^*_{L1} < a_{L2}/a^*_{L2} < a_{L3}/a^*_{L3} < \ldots < a_{LN}/a^*_{LN}. \qquad (3\text{-}6)$$

Relative Wages and Specialization

We are now prepared to look at the pattern of trade. This pattern depends on only one thing: the ratio of Home to Foreign wages. Once we know this ratio, we can determine who produces what.

Let w be the wage rate per hour in Home and w^* be the wage rate in Foreign. The ratio of wage rates is then w/w^*. The rule for allocating world production, then, is simply this: Goods will always be produced where it is cheapest to make them. The cost of making some good, say good i, is the unit labor requirement times the wage rate. To produce good i in Home will cost wa_{Li}. To produce the same good in Foreign will cost $w^*a^*_{Li}$. It will be cheaper to produce the good in Home if

$$wa_{Li} < w^*a^*_{Li},$$

which can be rearranged to yield

$$a^*_{Li}/a_{Li} > w/w^*.$$

On the other hand, it will be cheaper to produce the good in Foreign if

$$wa_{Li} > w^*a^*_{Li},$$

which can be rearranged to yield

$$a^*_{Li}/a_{Li} < w/w^*.$$

Thus we can restate the allocation rule: Any good for which $a^*_{Li}/a_{Li} > w/w^*$ will be produced in Home, while any good for which $a^*_{Li}/a_{Li} < w/w^*$ will be produced in Foreign.

We have already lined up the goods in increasing order of a_{Li}/a^*_{Li} (equation (3-6)). This criterion for specialization tells us that what happens is a "cut" in that lineup, determined by the ratio of the two countries' wage rates, w/w^*. All the goods to the left of the cut end up being produced in Home; all the goods to the right end up being produced in Foreign. (It is possible, as we will see in a moment, that the ratio of wage rates is exactly equal to the ratio of unit labor requirements for one good. In that case this borderline good may be produced in both countries.)

Table 3-3 offers a numerical example in which Home and Foreign both consume and are able to produce *five* goods: apples, bananas, caviar, dates, and enchiladas.

TABLE 3-3 Home and Foreign Unit Labor Requirements

Good	Home Unit Labor Requirement (a_{Li})	Foreign Unit Labor Requirement (a^*_{Li})	Relative Home Productivity Advantage (a^*_{Li}/a_{Li})
Apples	1	10	10
Bananas	5	40	8
Caviar	3	12	4
Dates	6	12	2
Enchiladas	12	9	0.75

The first two columns of this table are self-explanatory. The third column is the ratio of the Foreign unit labor requirement to the Home unit labor requirement for each good—or, stated differently, the relative Home productivity advantage in each good. We have labeled the goods in order of Home productivity advantage, with the Home advantage greatest for apples and least for enchiladas.

Which country produces which goods depends on the ratio of Home and Foreign wage rates. Home will have a cost advantage in any good for which its relative productivity is higher than its relative wage, and Foreign will have the advantage in the others. If, for example, the Home wage rate is five times that of Foreign (a ratio of Home wage to Foreign wage of five to one), apples and bananas will be produced in Home and caviar, dates, and enchiladas in Foreign. If the Home wage rate is only three times that of Foreign, Home will produce apples, bananas, and caviar, while Foreign will produce only dates and enchiladas.

Is such a pattern of specialization beneficial to both countries? We can see that it is by using the same method we used earlier: comparing the labor cost of producing a good directly in a country with that of indirectly "producing" it by producing another good and trading for the desired good. If the Home wage rate is three times the Foreign wage (put another way, Foreign's wage rate is one-third that of Home), Home will import dates and enchiladas. A unit of dates requires 12 units of Foreign labor to produce, but its cost in terms of Home labor, given the three-to-one wage ratio, is only 4 person-hours ($12 \div 3$). This cost of 4 person-hours is less than the 6 person-hours it would take to produce the unit of dates in Home. For enchiladas, Foreign actually has higher productivity along with lower wages; it will cost Home only 3 person-hours to acquire a unit of enchiladas through trade, compared with the 12 person-hours it would take to produce it domestically. A similar calculation will show that Foreign also gains; for each of the goods Foreign imports it turns out to be cheaper in terms of domestic labor to trade for the good rather than produce the good domestically. For example, it would take 10 hours of Foreign labor to produce a unit of apples; even with a wage rate only one-third that of Home workers, it will require only 3 hours of labor to earn enough to buy that unit of apples from Home.

In making these calculations, however, we have simply assumed that the relative wage rate is 3. How does this relative wage rate actually get determined?

Determining the Relative Wage in the Multigood Model

In the two-good model we determined relative wages by first calculating Home wages in terms of cheese and Foreign wages in terms of wine, then using the price of cheese relative to that of wine to deduce the ratio of the two countries' wage rates. We could do this because we knew that Home would produce cheese and Foreign wine. In the many-good case, who produces what can be determined only after we know the relative wage rate, so this procedure is unworkable. To determine relative wages in a multigood economy, we must look behind the relative demand for goods to the implied relative demand for labor. This is not a direct demand on the part of consumers; rather, it is a **derived demand** that results from the demand for goods produced with each country's labor.

The relative derived demand for Home labor will fall when the ratio of Home to Foreign wages rises, for two reasons. First, as Home labor becomes more expensive relative to Foreign labor, goods produced in Home also become relatively more expensive, and world demand for these goods falls. Second, as Home wages rise, fewer goods will be produced in Home and more in Foreign, further reducing the demand for Home labor.

We can illustrate these two effects using our numerical example. Suppose we start with the following situation: The Home wage is initially 3.5 times the Foreign wage. At that

level, Home would produce apples, bananas, and caviar while Foreign would produce dates and enchiladas. If the relative Home wage were to increase from 3.5 to just under 4, say 3.99, the pattern of specialization would not change, but as the goods produced in Home became relatively more expensive, the relative demand for these goods would decline and the relative demand for Home labor would decline with it.

Suppose now that the relative wage were to increase slightly from 3.99 to 4.01. This small further increase in the relative Home wage would bring about a shift in the pattern of specialization. Because it is now cheaper to produce caviar in Foreign than in Home, the production of caviar shifts from Home to Foreign. What does this imply for the relative demand for Home labor? Clearly it implies that as the relative wage rises from a little less than 4 to a little more than 4 there is an abrupt drop-off in the relative demand, as Home production of caviar falls to zero and Foreign acquires a new industry. If the relative wage continues to rise, relative demand for Home labor will gradually decline, then drop off abruptly at a relative wage of 8, at which wage production of bananas shifts to Foreign.

We can illustrate the determination of relative wages with a diagram like Figure 3-5. Unlike Figure 3-3, this diagram does not have relative quantities of goods or relative prices of goods on its axes. Instead it shows the relative quantity of labor and the relative wage rate. The world demand for Home labor relative to its demand for Foreign labor is shown by the curve *RD*. The world supply of Home labor relative to Foreign labor is shown by the line *RS*.

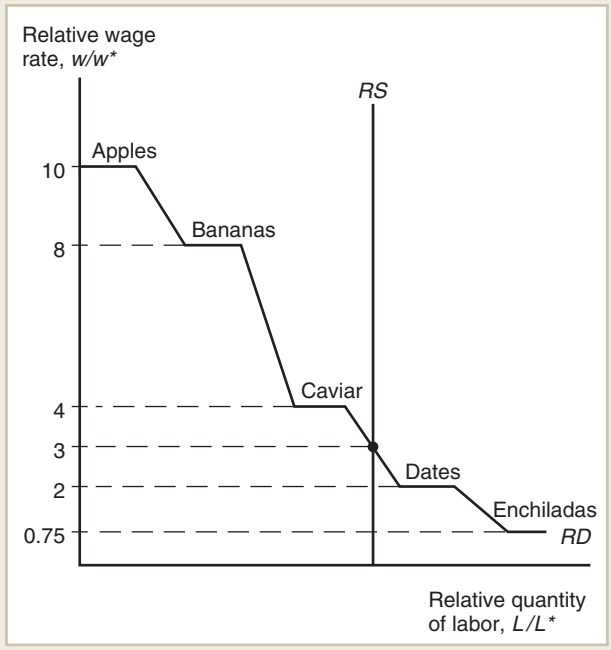
The relative supply of labor is determined by the relative size of Home and Foreign labor forces. Assuming that the number of person-hours available does not vary with the wage, the relative wage has no effect on relative labor supply and *RS* is a vertical line.

Our discussion of the relative demand for labor explains the "stepped" shape of *RD*. Whenever we increase the wage rate of Home workers relative to Foreign workers, the

Figure 3-5

Determination of Relative Wages

In a many-good Ricardian model, relative wages are determined by the intersection of the derived relative demand curve for labor *RD* with the relative supply *RS*.



relative demand for goods produced in Home will decline and the demand for Home labor will decline with it. In addition, the relative demand for Home labor will drop off abruptly whenever an increase in the relative Home wage makes a good cheaper to produce in Foreign. So the curve alternates between smoothly downward-sloping sections where the pattern of specialization does not change and "flats" where the relative demand shifts abruptly because of shifts in the pattern of specialization. As shown in the figure, these "flats" correspond to relative wages that equal the ratio of Home to Foreign productivity for each of the five goods.

The equilibrium relative wage is determined by the intersection of *RD* and *RS*. As drawn, the equilibrium relative wage is 3. At this wage, Home produces apples, bananas, and caviar while Foreign produces dates and enchiladas. The outcome depends on the relative size of the countries (which determines the position of *RS*) and the relative demand for the goods (which determines the shape and position of *RD*).

If the intersection of *RD* and *RS* happens to lie on one of the flats, both countries produce the good to which the flat applies.

Adding Transport Costs and Nontraded Goods

We now extend our model another step closer to reality by considering the effects of transport costs. Transportation costs do not change the fundamental principles of comparative advantage or the gains from trade. Because transport costs pose obstacles to the movement of goods and services, however, they have important implications for the way a trading world economy is affected by a variety of factors such as foreign aid, international investment, and balance of payments problems. While we will not deal with the effects of these factors yet, the multigood one-factor model is a good place to introduce the effects of transport costs.

First, notice that the world economy described by the model of the last section is marked by very extreme international specialization. At most there is one good that both countries produce; all other goods are produced either in Home or in Foreign, not in both.

There are three main reasons why specialization in the real international economy is not this extreme:

1. The existence of more than one factor of production reduces the tendency toward specialization (as we see in the next two chapters).
2. Countries sometimes protect industries from foreign competition (discussed at length in Chapters 8 through 11).
3. It is costly to transport goods and services, and in some cases the cost of transportation is enough to lead countries into self-sufficiency in certain sectors.

In the multigood example of the last section we found that at a relative Home wage of 3, Home could produce apples, bananas, and caviar more cheaply than Foreign, while Foreign could produce dates and enchiladas more cheaply than Home. *In the absence of transport costs,* then, Home will export the first three goods and import the last two.

Now suppose there is a cost to transporting goods, and that this transport cost is a uniform fraction of production cost, say 100 percent. This transportation cost will discourage trade. Consider, for example, dates. One unit of this good requires 6 hours of Home labor or 12 hours of Foreign labor to produce. At a relative wage of 3, 12 hours

of Foreign labor cost only as much as 4 hours of Home labor; so in the absence of transport costs Home imports dates. With a 100 percent transport cost, however, importing dates would cost the equivalent of 8 hours of Home labor, so Home will produce the good for itself instead.

A similar cost comparison shows that Foreign will find it cheaper to produce its own caviar than import it. A unit of caviar requires 3 hours of Home labor to produce. Even at a relative Home wage of 3, which makes this the equivalent of 9 hours of Foreign labor, this is cheaper than the 12 hours Foreign would need to produce caviar for itself. In the absence of transport costs, then, Foreign would find it cheaper to import caviar than to make it domestically. With a 100 percent cost of transportation, however, imported caviar would cost the equivalent of 18 hours of Foreign labor and would therefore be produced locally instead.

The result of introducing transport costs in this example, then, is that while Home still exports apples and bananas and imports enchiladas, caviar and dates become **nontraded goods,** which each country produces for itself.

In this example we have assumed that transport costs are the same fraction of production cost in all sectors. In practice there is a wide range of transportation costs. In some cases transportation is virtually impossible: Services such as haircuts and auto repair cannot be traded internationally (except where there is a metropolitan area that straddles a border, like Detroit, Michigan–Windsor, Ontario). There is also little international trade in goods with high weight-to-value ratios, like cement. (It is simply not worth the transport cost of importing cement, even if it can be produced much more cheaply abroad.) Many goods end up being nontraded either because of the absence of strong national cost advantages or because of high transportation costs.

The important point is that nations spend a large share of their income on nontraded goods. This observation is of surprising importance in our later discussion of international transfers of income (Chapter 5) and in international monetary economics.

Empirical Evidence on the Ricardian Model

The Ricardian model of international trade is an extremely useful tool for thinking about the reasons why trade may happen and about the effects of international trade on national welfare. But is the model a good fit to the real world? Does the Ricardian model make accurate predictions about actual international trade flows?

The answer is a heavily qualified yes. Clearly there are a number of ways in which the Ricardian model makes misleading predictions. First, as mentioned in our discussion of nontraded goods, the simple Ricardian model predicts an extreme degree of specialization that we do not observe in the real world. Second, the Ricardian model assumes away effects of international trade on the distribution of income *within* countries, and thus predicts that countries as a whole will always gain from trade; in practice, international trade has strong effects on income distribution. Third, the Ricardian model allows no role for differences in resources among countries as a cause of trade, thus missing an important aspect of the trading system (the focus of Chapter 4). Finally, the Ricardian model neglects the possible role of economies of scale as a cause of trade, which leaves it unable to explain the large trade flows between apparently similar nations—an issue discussed in Chapter 6.

In spite of these failings, however, the basic prediction of the Ricardian model—that countries should tend to export those goods in which their productivity is relatively high—has been strongly confirmed by a number of studies over the years.

Several classic tests of the Ricardian model were performed using data from the early post-World War II period comparing British with American productivity and trade.[4] This was an unusually illuminating comparison. British labor productivity was less than American in almost every sector. Thus the United States had an absolute advantage in everything. Nonetheless, the amount of British overall exports was about as large as American at the time. Clearly then, there must have been some sectors in which Britain had a comparative advantage in spite of its lower absolute productivity. The Ricardian model would predict that these would be the sectors in which the United States' productivity advantage was smallest.

Figure 3-6 illustrates the evidence in favor of the Ricardian model, using data presented in a paper by the Hungarian economist Bela Balassa in 1963. The figure compares the ratio of U.S. to British exports in 1951 with the ratio of U.S. to British labor productivity for 26 manufacturing industries. The productivity ratio is measured on the horizontal axis, the export ratio on the vertical axis. Both axes are given a logarithmic scale; this is not of any basic importance, but turns out to produce a clearer picture.

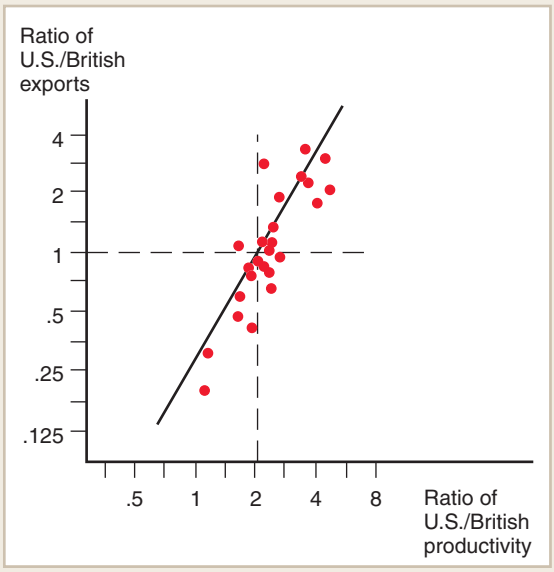
Ricardian theory would lead us broadly to expect that the higher the relative productivity in the U.S. industry, the more likely U.S. rather than U.K. firms would export in that industry. And that is what Figure 3-6 shows. In fact, the scatterplot lies quite close to an upward-sloping line, also shown in the figure. Bearing in mind that the data used for this comparison are, like all economic data, subject to substantial measurement errors, the fit is remarkably close.

As expected, the evidence in Figure 3-6 confirms the basic insight that trade depends on *comparative,* not *absolute* advantage. At the time to which the data refer, U.S. industry had much higher labor productivity than British industry—on average about twice as high. The commonly held misconception that a country can be competitive only if it can match other

Figure 3-6

Productivity and Exports

A comparative study showed that U.S. exports were high relative to British exports in industries in which the United States had high relative labor productivity. Each dot represents aa different industry.



[4] The pioneering study by G. D. A. MacDougall is listed in Further Reading at the end of the chapter. A well-known follow-up study, on which we draw here, was Bela Balassa, "An Empirical Demonstration of Classical Comparative Cost Theory," *Review of Economics and Statistics* 45 (August 1963), pp. 231–238: we use Balassa's numbers as an illustration.

countries' productivity, which we discussed earlier in this chapter, would have led one to predict a U.S. export advantage across the board. The Ricardian model tells us, however, that having high productivity in an industry compared with foreigners is not enough to ensure that a country will export that industry's products; the relative productivity must be high compared with relative productivity in other sectors. As it happens, U.S. productivity exceeded British in all 26 sectors (indicated by dots) shown in Figure 3-6, by margins ranging from 11 to 366 percent. In 12 of the sectors, however, Britain actually had larger exports than the United States. A glance at the figure shows that, in general, U.S. exports were larger than U.K. exports only in industries where the U.S. productivity advantage was somewhat more than two to one.

More recent evidence on the Ricardian model has been less clear-cut. In part, this is because the growth of world trade and the resulting specialization of national economies means that we do not get a chance to see what countries do badly! In the world economy of the 21st century, countries often do not produce goods for which they are at a comparative disadvantage, so there is no way to measure their productivity in those sectors. For example, most countries do not produce airplanes, so there are no data on what their unit labor requirements would be if they did. Nonetheless, there are several pieces of evidence suggesting that differences in labor productivity continue to play an important role in determining world trade patterns.

Perhaps the most striking demonstration of the continuing usefulness of the Ricardian theory of comparative advantage is the way it explains the emergence of China as an export powerhouse in some industries. Overall, Chinese labor productivity in manufacturing, although rising, remains very low by American or European standards. In some industries, however, the Chinese productivity disadvantage is not as large as it is on average—and in these industries China has become one of the world's largest producers and exporters.

Table 3-4 illustrates this point with some estimates based on 1995 data. The researchers compared Chinese output and productivity with that of Germany in a number of industries. On average, they found that Chinese productivity was only 5 percent of that of Germany, and that in 1995 total Chinese manufacturing output was still almost 30 percent less than Germany's total manufacturing production.

In apparel (that is, clothing), however, Chinese productivity was closer to German levels. China still had an *absolute* disadvantage in clothing production, with only about a fifth of German productivity. But because China's relative productivity in apparel was so much higher than it was in other industries, China had a strong comparative advantage in apparel—and China's apparel industry was eight times the size of Germany's apparel industry.

In sum, while few economists believe that the Ricardian model is a fully adequate description of the causes and consequences of world trade, its two principal implications—that productivity differences play an important role in international trade and that it is comparative rather than absolute advantage that matters—do seem to be supported by the evidence.

TABLE 3-4 China versus Germany, 1995

	Chinese output per worker as % of Germany	Total Chinese output as % of Germany
All manufacturing	5.2	71.6
Apparel	19.7	802.2

Source: Ren Ruoen and Bai Manying, "China's Manufacturing Industry in an International Perspective: A China-Germany Comparison," *Economie internationale,* no. 92–2002/4, pp. 103–130.

SUMMARY

1. We examined the *Ricardian model,* the simplest model that shows how differences between countries give rise to trade and gains from trade. In this model labor is the only factor of production and countries differ only in the productivity of labor in different industries.
2. In the Ricardian model, countries will export goods that their labor produces relatively efficiently and import goods that their labor produces relatively inefficiently. In other words, a country's production pattern is determined by *comparative advantage.*
3. That trade benefits a country can be shown in either of two ways. First, we can think of trade as an indirect method of production. Instead of producing a good for itself, a country can produce another good and trade it for the desired good. The simple model shows that whenever a good is imported it must be true that this indirect "production" requires less labor than direct production. Second, we can show that trade enlarges a country's consumption possibilities, implying *gains from trade.*
4. The distribution of the gains from trade depends on the relative prices of the goods countries produce. To determine these relative prices it is necessary to look at the *relative world supply and demand* for goods. The relative price implies a *relative wage rate* as well.
5. The proposition that trade is beneficial is unqualified. That is, there is no requirement that a country be "competitive" or that the trade be "fair." In particular, we can show that three commonly held beliefs about trade are wrong. First, a country gains from trade even if it has lower productivity than its trading partner in all industries. Second, trade is beneficial even if foreign industries are competitive only because of low wages. Third, trade is beneficial even if a country's exports embody more labor than its imports.
6. Extending the one-factor, two-good model to a world of many commodities does not alter these conclusions. The only difference is that it becomes necessary to focus directly on the relative demand for labor to determine relative wages rather than to work via relative demand for goods. Also, a many-commodity model can be used to illustrate the important point that transportation costs can give rise to a situation in which some nontraded goods exist.
7. While some of the predictions of the Ricardian model are clearly unrealistic, its basic prediction—that countries will tend to export goods in which they have relatively high productivity—has been confirmed by a number of studies.

KEY TERMS

absolute advantage, p. 32
comparative advantage, p. 29
derived demand, p. 45
gains from trade, p. 36
general equilibrium analysis, p. 33
nontraded goods, p. 48
opportunity cost, p. 28
partial equilibrium analysis, p. 33
pauper labor argument, p. 41
production possibility frontier, p. 30
relative demand curve, p. 33
relative supply curve, p. 33
relative wage, p. 38
Ricardian model, p. 29
unit labor requirement, p. 29

PROBLEMS

myeconlab

1. Home has 1,200 units of labor available. It can produce two goods, apples and bananas. The unit labor requirement in apple production is 3, while in banana production it is 2.
   a. Graph Home's production possibility frontier.
   b. What is the opportunity cost of apples in terms of bananas?
   c. In the absence of trade, what would the price of apples in terms of bananas be? Why?
2. Home is as described in problem 1. There is now also another country, Foreign, with a labor force of 800. Foreign's unit labor requirement in apple production is 5, while in banana production it is 1.
   a. Graph Foreign's production possibility frontier.
   b. Construct the world relative supply curve.
3. Now suppose world relative demand takes the following form: Demand for apples/demand for bananas = price of bananas/price of apples.
   a. Graph the relative demand curve along with the relative supply curve.
   b. What is the equilibrium relative price of apples?
   c. Describe the pattern of trade.
   d. Show that both Home and Foreign gain from trade.
4. Suppose that instead of 1,200 workers, Home had 2,400. Find the equilibrium relative price. What can you say about the efficiency of world production and the division of the gains from trade between Home and Foreign in this case?
5. Suppose that Home has 2,400 workers, but they are only half as productive in both industries as we have been assuming. Construct the world relative supply curve and determine the equilibrium relative price. How do the gains from trade compare with those in the case described in problem 4?
6. "Chinese workers earn only $.50 an hour; if we allow China to export as much as it likes, our workers will be forced down to the same level. You can't import a $10 shirt without importing the $.50 wage that goes with it." Discuss.
7. Japanese labor productivity is roughly the same as that of the United States in the manufacturing sector (higher in some industries, lower in others), while the United States is still considerably more productive in the service sector. But most services are nontraded. Some analysts have argued that this poses a problem for the United States, because our comparative advantage lies in things we cannot sell on world markets. What is wrong with this argument?
8. Anyone who has visited Japan knows it is an incredibly expensive place; although Japanese workers earn about the same as their U.S. counterparts, the purchasing power of their incomes is about one-third less. Extend your discussion from question 7 to explain this observation. (Hint: Think about wages and the implied prices of nontraded goods.)
9. How does the fact that many goods are nontraded affect the extent of possible gains from trade?
10. We have focused on the case of trade involving only two countries. Suppose that there are many countries capable of producing two goods, and that each country has only one factor of production, labor. What could we say about the pattern of production and trade in this case? (Hint: Try constructing the world relative supply curve.)

FURTHER READING

Donald Davis. "Intraindustry Trade: A Heckscher-Ohlin-Ricardo Approach." *Journal of International Economics* 39 (November 1995), pp. 201–226. A recent revival of the Ricardian approach to explain trade between countries with similar resources.

Rudiger Dornbusch, Stanley Fischer, and Paul Samuelson. "Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods." *American Economic Review* 67 (December 1977), pp. 823–839. More recent theoretical modeling in the Ricardian mode, developing the idea of simplifying the many-good Ricardian model by assuming that the number of goods is so large as to form a smooth continuum.

Giovanni Dosi, Keith Pavitt, and Luc Soete. *The Economics of Technical Change and International Trade.* Brighton: Wheatsheaf, 1988. An empirical examination that suggests that international trade in manufactured goods is largely driven by differences in national technological competences.

Stephen Golub and Chang-Tai Hsieh. "Classical Ricardian Theory of Comparative Advantage Revisited." *Review of International Economics* 8(2), 2000, pp. 221–234. A modern statistical analysis of the relationship between relative productivity and trade patterns, which finds reasonably strong correlations.

G. D. A. MacDougall. "British and American Exports: A Study Suggested by the Theory of Comparative Costs." *Economic Journal* 61 (December 1951), pp. 697–724; 62 (September 1952), pp. 487–521. In this famous study, MacDougall used comparative data on U.S. and U.K. productivity to test the predictions of the Ricardian model.

John Stuart Mill. *Principles of Political Economy.* London: Longmans, Green, 1917. Mill's 1848 treatise extended Ricardo's work into a full-fledged model of international trade.

David Ricardo. *The Principles of Political Economy and Taxation.* Homewood, IL: Irwin, 1963. The basic source for the Ricardian model is Ricardo himself in this book, first published in 1817.