2. The quotation from Federal Reserve Chairman Ben Bernanke at the beginning of the chapter is from a speech that he presented in Jackson Hole, Wyoming, on August 25, 2006, titled "Global Economic Integration: What's New and What's Not?" The full transcript of the speech is available at: http://www.federalreserve.gov/boarddocs/speeches/2006/. Read this speech and answer the following questions:
   a. List three ways in which international trade today is not that different from the trade that occurred before World War I.
   b. List three ways in which international trade today does differ from the trade that occurred before World War I

2

Trade and Technology: The Ricardian Model

England exported cloth in exchange for wine, because, by so doing her industry was rendered more productive to her; she had more cloth and wine than if she had manufactured both for herself; and Portugal imported cloth and exported wine, because the industry of Portugal could be more beneficially employed for both countries in producing wine.

. . . It would therefore be advantageous for [Portugal] to export wine in exchange for cloth. This exchange might even take place, notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England.

David Ricardo,
On the Principles of Political Economy and Taxation, 1821

Comparative advantage is the best example of an economic principle that is undeniably true yet not obvious to intelligent people.

Paul Samuelson,
"The Way of an Economist," 1969[1]

Pick any manufactured product, and you will most likely find that it is traded among a number of countries. Let's choose snowboards as an example. In 2005 the United States **imported** (that is, purchased from other countries) 1.34 million snowboards at an average wholesale price of $44 each, so the total value of snowboard imports was about $59 million. The United States imported snowboards from 20 different countries; Table 2-1 identifies the 12 countries with the highest dollar amount of snowboard sales to the United States.

[1] Samuelson, Paul A. 1969. "The Way of an Economist." In *International Economic Relations: Proceedings of the Third Congress of the International Economic Association,* ed. Paul A. Samuelson, 1–11. London: Macmillan.

TABLE 2-1

U.S. Imports of Snowboards, 2005

Rank	Country	Value of Imports ($ millions)	Quantity of Snowboards (thousands)	Average Price ($/board)
1	China	$18.1	355	$51
2	Austria	17.8	186	95
3	Canada	9.1	123	74
4	Mexico	5.0	565	9
5	Spain	2.2	25	84
6	Poland	1.9	25	74
7	Tunisia	1.3	7	163
8	France	1.1	9	118
9	Germany	1.0	8	119
10	Taiwan	0.5	20	24
11	Bulgaria	0.3	4	57
12	Switzerland	0.2	1	135
13–20	Various countries	0.3	6	60
	All 20 countries	$58.8	1,340	$44

Source: U.S. customs import data.

At the top of the list is China, **exporting** (that is, selling to another country) more than $18 million worth of snowboards to the United States, followed closely by Austria, selling just under $18 million. These two countries sell considerably more than the next group, consisting of Canada and Mexico, which sell approximately $9 million and $5 million, respectively, to the United States. Then, a larger group consisting of mostly European countries—Spain, Poland, France, and Germany, as well as Tunisia, a country on the north coast of Africa that is a former colony of France—sell between $1 million and $2 million each to the United States. Less than $1 million of imports comes from each of Taiwan, Bulgaria, Switzerland, and eight other countries. With all the manufacturing capability the United States has, why does it purchase snowboards from these countries instead of producing them domestically?

Brian Bailey/IndexStock

Where did this snowboard come from?

The first chapters of this book look at various reasons why countries trade goods with each other, including the following:

- Differences in the **technology** used in each country (that is, differences in each country's ability to manufacture products)
- Differences in the total amount of **resources** (including labor, capital, and land) found in each country
- Differences in the costs of **outsourcing** (that is, producing the various parts of a good in different countries and then assembling it in a final location)

- The **proximity** of countries to each other (that is, how close they are to one another)

In this chapter, we focus on the first of these reasons as an explanation for trade—technology differences across countries. This explanation is often called the **Ricardian model** because it was proposed by the nineteenth-century economist David Ricardo. This model explains how the level of a country's technology affects the wages paid to labor, such that countries with better technologies have higher wages. This, in turn, helps to explain how a country's technology affects its **trade pattern,** the products that it imports and exports.

1 Reasons for Trade

Besides technology differences across countries, which is the focus of the Ricardian model, there are many other reasons why countries trade goods. Before we get into the details of the Ricardian model, let's briefly explore the other reasons for trade listed previously.

Proximity

The proximity of countries is a reason for trade primarily because it affects the costs of transportation. Countries that are near each other will usually have lower shipping costs added to the cost of their traded goods. The proximity of countries to each other helps to explain why Canada is among the top exporters of snowboards to the United States and why Canada is the United States' largest trading partner overall. There are many other examples of how the closeness of countries affects trade partners. The largest trading partner of many European countries is another European country, and the largest trading partner of many Asian countries is Japan or China. Sometimes neighboring countries take advantage of their proximity by joining into a **free-trade area,** in which the countries have no restrictions on trade between them. We study free-trade areas in Chapters 6 and 11.

Resources

Proximity is only a partial explanation for trade patterns. As you can see in Table 2-1, Austria sells twice the value of snowboards to the United States as does Canada, despite being farther away, and Mexico sells one-half the value as Canada, even though it is just as close to the United States as is Canada. Why do Austria and Canada rank higher than Mexico in their sales of snowboards to the United States? Among other reasons, Austria and Canada have cold climates and mountains, making skiing and snowboarding very popular, in contrast to Mexico. In many cases, the local production of (and expertise for) ski and snowboard equipment develops as a result of being in a place where snow sports are common. This local production occurs because of either high demand for equipment or the ready supply of a complementary good (such as a snowy mountain). This is an example of how the geography

of a country (mountains and climate, in this case) affects its exports. Ski resorts can also be found in many of the other countries listed in Table 2-1, including France, Switzerland, Spain, and Bulgaria.

Geography includes the **natural resources** (such as land and minerals) found in a country, as well as its **labor resources** (labor of various education and skill levels) and **capital** (machinery and structures). A country's resources are often collectively called its **factors of production,** the land, labor, and capital used to produce goods and services. In Chapters 3 and 4, we study how the resources of a country influence its trade patterns and how trade leads to economic gains or losses for different factors of production. Chapter 5 deals with the movement of factors between countries.

Having mountains with ski resorts obviously does not apply to Mexico, Tunisia, and Taiwan, however, which are the fourth-, seventh-, and tenth-largest sellers of snowboards to the United States. What explains these exports? A hint is provided by noticing that the wholesale price of a snowboard purchased by the United States from these countries differs quite a bit: Mexico and Taiwan sell snowboards to the U.S. for $9 and $24, respectively, whereas Tunisia sells them for $163, the highest price, comparable with Switzerland ($135), Germany ($119), and France ($118). The very low prices from Mexico and Taiwan indicate that the snowboards they are selling to the United States are not finished products but are unfinished boards imported into the U.S. for further processing. This type of trade in unfinished goods is an example of *outsourcing,* a process in which a company spreads its production activities across several countries and trades semifinished products between them. Outsourcing, which has become increasingly common in recent years, is examined in detail in Chapter 7.

The snowboards from Tunisia are selling at such a high price that one would expect that they are finished, but we could also guess that production in this former French colony is controlled by Rossignol, a large French manufacturer of snowboards, skis, and related equipment. If snowboard plants in Tunisia are owned by Rossignol or other French firms, then this would be an example of **foreign direct investment,** whereby a company in one country owns a factory in another. This is a topic we study in Chapter 5.

Absolute Advantage

We've now explained some possible reasons for many countries to export snowboards to the United States, but we haven't yet explained the imports from China, the largest exporter of snowboards to the United States in 2005, and Germany, the ninth largest. Germany has the Alps on its southern border, so natural resources are one reason it exports snowboards. Many people, however, may think the primary reason is that Germany has the world's best *technology* for producing snowboards. In fact, Germany is recognized as a world leader in the methods to produce many goods, including chemicals, machine tools, motor vehicles, and steel products. When a country has the best technology for producing a good, it has an **absolute advantage** in the production of that good. But if Germany has an absolute advantage in producing snowboards, why does the United States import more than *40 times* as many snowboards from China, which uses less advanced technologies than Germany in most industries? Furthermore, while Germany is a world leader in many technologies, so is the United States. So why should the United States import snowboards from Germany or China at all? Why doesn't it just produce all the snowboards it needs with U.S. technology and factors of production?

Comparative Advantage

These questions indicate that absolute advantage is not, in fact, a good explanation for trade patterns. This is one of the key lessons from this chapter. Instead, **comparative advantage** is the primary explanation for trade among countries. To get an idea of what comparative advantage means, let us consider the example of trade between Portugal and England, as described by David Ricardo.

To keep things simple, Ricardo considered just two commodities, wine and cloth. Ricardo allowed Portugal to have an absolute advantage in the production of both goods. Portugal's absolute advantage may reflect, for example, its more favorable climate for growing grapes and raising sheep. Even though Portugal can produce wine and cloth more easily than England, England is still able to produce both cloth and wine, but it is *relatively more difficult* to produce wine in England than cloth—as any visitor to England will know, it lacks the regular sunshine needed to produce good grapes! Based on these assumptions, Ricardo argued that England would have a comparative advantage in producing cloth and would export cloth to Portugal, whereas Portugal would have comparative advantage in producing wine and would export wine to England.

From this example, we can see that a country has comparative advantage in producing those goods that it produces best *compared with* how well it produces other goods. That is, Portugal is better at producing wine than cloth, and England is better at producing cloth than wine, even though Portugal is better than England at producing both goods. This is the idea behind the quotation from Ricardo at the start of the chapter—it will be advantageous for Portugal to import cloth from England because England has a comparative advantage in cloth. In our snowboard example, we would expect that China has a disadvantage compared with Germany or the United States in producing many manufactured goods, but it is still better at producing snowboards than some other goods, so it is able to export snowboards to the United States.

It will take us most of the chapter to explain the concept of comparative advantage and why it works as an explanation for trade patterns. As indicated by the other quotation at the beginning of the chapter, from Nobel laureate Paul Samuelson, this concept is far from obvious, and the student who has mastered it will already have come a long way in his or her study of international trade.

NETWORK

Go to http://www.ita.doc.gov/td/industry/otea/trade-detail, and choose the "HS 10-Digit Tool," which provides data on U.S. trade. Products are broken down according to the Harmonized System categories. Choose a 2-digit category, then a 6-digit category, and then a 10-digit category. You will get data on U.S. imports or exports by country for this particular product. Pick a product, and list the top ten countries selling it to the United States. For each country, state the reasons why you believe that country exports this product to the United States.

SIDE BAR

David Ricardo and Mercantilism

David Ricardo (1772–1823) was one of the great classical economists, and the first model we study in this book is named after him. At the time that Ricardo was writing, there was a school of economic thought known as *mercantilism*. Mercantilists believed that exporting (selling goods to other countries) was good because it generated gold and silver for the national treasury and that importing (buying goods from other countries) was bad because it drained gold and silver from the national treasury. To ensure that a country exported a lot and imported only a little, the mercantilists were in favor of high *tariffs* on goods, which are taxes that must be paid at the border when a good is imported. The mercantilist school of thought was discredited shortly after the time that Ricardo wrote, but some of these old ideas are still advocated today. For example, the United States sometimes insists that other countries should buy more from its companies and sometimes restricts import purchases from other countries; proponents of these ideas are sometimes called "mercantilists."

Ricardo was interested in showing that countries could benefit from international trade without having to use tariffs and without requiring exports to be higher than imports. He considered a case that contrasted sharply with what mercantilists believed to be best for a nation: in his writings about trade, Ricardo assumed that the value of exports equaled the value of imports (a situation called *balanced trade*) and that countries engaged in *free trade*, with no tariffs or other restrictions to limit the flow of goods across borders. Under these assumptions, can international trade benefit every country? Ricardo showed that it could. All countries gain from trade by exporting the goods in which they have comparative advantage.

David Ricardo

Ricardo's ideas are so important that it will take some time to explain how and why they work. It is no exaggeration to say that many of the major international institutions in the world today, including the United Nations, the World Bank, and the World Trade Organization, are founded at least in part on the idea that free trade between countries brings gains for all trading partners. This idea comes from the writings of David Ricardo (and Adam Smith, a great classical economist of the eighteenth century).

2 Ricardian Model

In developing the Ricardian model of trade, we will work with an example similar to that used by Ricardo; instead of wine and cloth, however, the two goods will be wheat and cloth. Wheat and other grains (including barley, rice, and so on) are major exports of the United States and Europe, while many types of cloth are imported into these countries. In our example, the home country (we will call it just "Home") will end up with this trade pattern, exporting wheat and importing cloth.

The Home Country

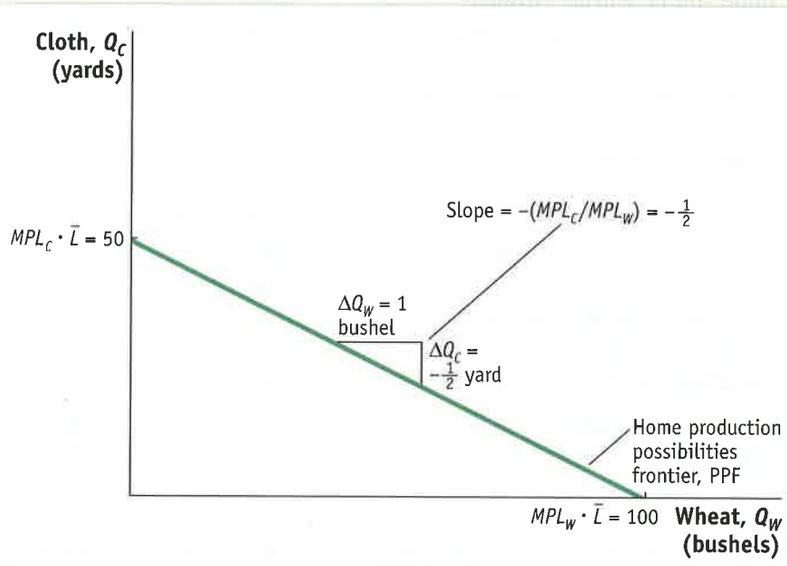
To simplify our example, we will ignore the role of land and capital and suppose that both goods are produced with labor alone. At Home, one worker can produce 4 bushels of wheat or 2 yards of cloth. This production can be expressed in terms of the **marginal product of labor (MPL)** for each good. Recall from your study of microeconomics that the marginal product of labor

is the extra output obtained by using one more unit of labor.[1] In Home, one worker produces 4 bushels of wheat, so $MPL_W = 4$. Alternatively, one worker can produce 2 yards of cloth, so $MPL_C = 2$.

Home Production Possibilities Frontier Using the marginal products for producing wheat and cloth, we can graph Home's **production possibilities frontier (PPF).** Suppose there are $\overline{L} = 25$ workers in the home country (the bar over the letter L indicates our assumption that the amount of labor in Home stays constant). If all these workers were employed in wheat, they could produce $Q_W = MPL_W \cdot \overline{L} = 4 \cdot 25 = 100$ bushels. Alternatively, if they were all employed in cloth, they could produce $Q_C = MPL_C \cdot \overline{L} = 2 \cdot 25 = 50$ yards. The production possibilities frontier is a straight line between these two points at the corners, as shown in Figure 2-1.

The straight-line PPF is a special feature of the Ricardian model, which follows from the assumption that the marginal products of labor are *constant*. That is, regardless of how much wheat or cloth is already being produced, one extra hour of labor yields an additional 4 bushels of wheat or 2 yards of cloth. There are *no diminishing returns* in the Ricardian model because it ignores the role of land and capital.

FIGURE 2-1



Home Production Possibilities Frontier
The Home PPF is a straight line between 50 yards of cloth and 100 bushels of wheat. The slope of the PPF equals the negative of the opportunity cost of wheat, that is, the amount of cloth that must be given up ($\frac{1}{2}$ yard) to obtain 1 more bushel of wheat. Equivalently, the magnitude of the slope can be expressed as the ratio of the marginal products of labor for the two goods.

[1] A special assumption of the Ricardian model is that there are no diminishing returns to labor, so the marginal product of labor is constant. That assumption will no longer be made in the next chapter, when we introduce capital and land, along with labor, as factors of production.

Given this property, the slope of the PPF in Figure 2-1 can be calculated as the ratio of the quantity of cloth produced to the quantity of wheat produced at the corners, as follows:

$$\text{Slope of PPF} = -\frac{50}{100} = -\frac{MPL_C \cdot \overline{L}}{MPL_W \cdot \overline{L}} = -\frac{MPL_C}{MPL_W} = -\frac{1}{2}$$

Ignoring the minus sign, the slope equals the ratio of marginal products of the two goods. The slope is also the **opportunity cost** of wheat, the amount of cloth that must be given up to obtain one more unit of wheat.[2] To see this, suppose that Q_W is increased by 1 bushel. It takes one worker to produce 4 bushels of wheat, so increasing Q_W by 1 bushel means that one-quarter of a worker's time must be withdrawn from the cloth industry and shifted into wheat production. This shift would reduce cloth output by $\frac{1}{2}$ yard, the amount of cloth that could have been produced by one-quarter of a worker's time. Thus, $\frac{1}{2}$ yard of cloth is the opportunity cost of obtaining 1 more bushel of wheat and is the slope of the PPF.

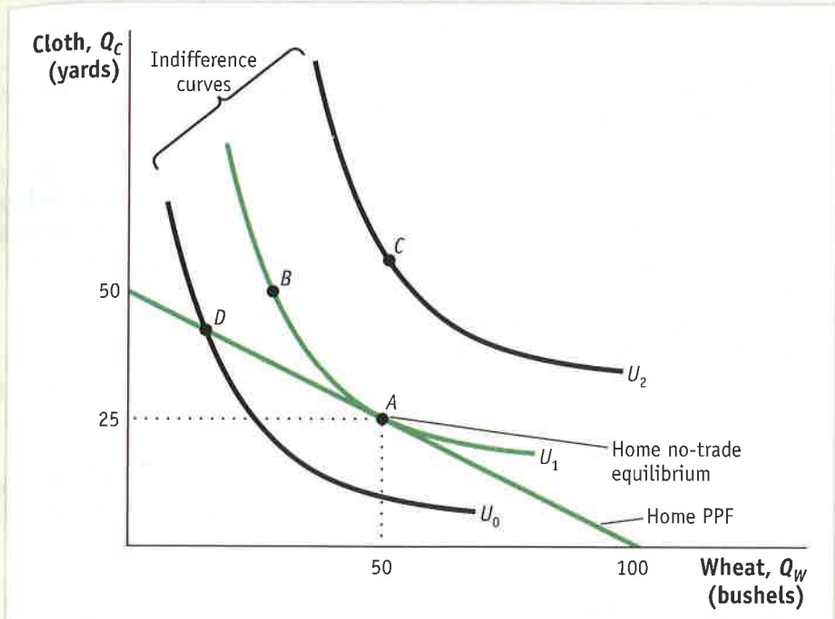
Home Indifference Curve With this production possibilities frontier, what combination of wheat and cloth will Home actually produce? The answer depends on the country's demand for each of the two goods. There are several ways to represent demand in the Home economy, but we will start by using **indifference curves.** Each indifference curve shows the combinations of two goods, such as wheat and cloth, that a person or economy can consume and be equally satisfied.

In Figure 2-2, the consumer is indifferent between points A and B, for example. Both of these points lie on an indifference curve U_1 associated with a given level of satisfaction, or **utility.** Point C lies on a higher indifference curve, U_2, indicating that it gives a higher level of utility, while point D lies on a lower indifference curve, U_0, indicating that it gives a lower level of utility. It is common to use indifference curves to reflect the utility that an individual consumer receives from various consumption points. In Figure 2-2, we go a step further, however, and apply this idea to an entire country. That is, the indifference curves in Figure 2-2 show the preferences of an entire country. The combinations of wheat and cloth on U_0 give consumers in the country lower utility than the combinations on indifference curve U_1, which in turn gives lower utility than the combinations of wheat and cloth on U_2.

Home Equilibrium In the absence of international trade, the production possibilities frontier acts like a budget constraint for the country, and with perfectly competitive markets, the economy will produce at the point of highest utility subject to the limits imposed by its PPF. The point of highest utility is at point A in Figure 2-2, where Home consumes 25 yards of cloth and 50 bushels of wheat. This bundle of goods gives Home the highest level of utility possible (indifference curve U_1) given the limits of its PPF. Notice that

[2] Notice that the slope of the PPF is the opportunity cost of the good on the *horizontal* axis—wheat, in this case.

FIGURE 2-2



Home Equilibrium with No Trade Points A and B lie on the same indifference curve and give the Home consumers the level of utility U_1. The highest level of Home utility on the PPF is obtained at point A, which is the no-trade equilibrium. Point D is also on the PPF but would give lower utility. Point C represents a higher utility level but is off of the PPF, so it is not attainable in the absence of international trade.

Home could produce at other points such as point D, but this point would give a lower level of utility than point A (that is, point D would offer lower utility because U_0 is lower than U_1). Other consumption points, such as C, would give higher levels of utility than point A but cannot be obtained in the absence of international trade because they lie outside of Home's PPF.

We will refer to point A as the "no-trade" or the "pretrade" equilibrium for Home.[3] What we really mean by this phrase is "no *international* trade." The Home country is able to reach point A by having its own firms produce wheat and cloth and selling these goods to its own consumers. We are assuming that there are many firms in each of the wheat and cloth industries, so the firms act under perfect competition and take the market prices for wheat and cloth as given. The idea that perfectly competitive markets lead to the highest level of well-being for consumers—as illustrated by the highest level of utility at point A—is an example of the "invisible hand" that Adam Smith (1723–1790) wrote about in his famous book *The Wealth of Nations.* Like an "invisible hand," competitive markets lead firms to produce the amount of goods that results in the highest level of well-being for consumers.

[3] We will also refer to point A as the "autarky" equilibrium, since "autarky" means a situation in which the country does not engage in international trade.

Opportunity Cost and Prices While the slope of the PPF reflects the opportunity cost of producing one more bushel of wheat, under perfect competition the opportunity cost of wheat should also equal the relative price of wheat, as follows from the economic principle that price reflects the opportunity cost of a good. We can now check that this equality between the opportunity cost and the relative price of wheat holds at point A.

Wages We solve for the prices of wheat and cloth using an indirect approach, by first reviewing how wages are determined. In competitive labor markets, firms hire workers up to the point at which the cost of one more hour of labor (the wage) equals the value of one more hour of production. In turn, the value of one more hour of labor equals the amount of goods produced in that hour (the marginal product of labor) times the price of the good (P_W for the price of wheat and P_C for the price of cloth). That is to say, in the wheat industry, labor will be hired up to the point at which the wage equals $P_W \cdot MPL_W$, and in the cloth industry labor will be hired up to the point at which the wage equals $P_C \cdot MPL_C$.

If we assume that labor is perfectly free to move between these two industries and that workers will choose to work in the industry for which the wage is highest, then wages must be equalized across the two industries. If the wages were not the same in the two industries, laborers in the low-wage industry would have an incentive to move to the high-wage industry; this would, in turn, lead to an abundance of workers and a decrease in the wage in the high-wage industry and a scarcity of workers and an increase in the wage in the low-wage industry. This movement of labor would continue until wages are equalized between the two industries.

We can use the equality of the wage across industries to obtain the following equation:

$$P_W \cdot MPL_W = P_C \cdot MPL_C$$

By rearranging terms, we see that

$$P_W/P_C = MPL_C/MPL_W$$

The right-hand side of this equation is the slope of the production possibilities frontier, which is the opportunity cost of obtaining one more bushel of wheat, and the left-hand side of the equation is the **relative price** of wheat, as we will explain in the next paragraph. This equation says that the relative price of wheat (on the left) and opportunity cost of wheat (on the right) must be equal in the no-trade equilibrium at point A.

To understand why we measure the relative price of wheat as the ratio P_W/P_C, suppose that a bushel of wheat costs \$3 and a yard of cloth costs \$6. Then \$3/\$6 = 1/2, which shows that the relative price of wheat is $\frac{1}{2}$, that is, $\frac{1}{2}$ of a yard of cloth (or half of \$6) must be given up to obtain one bushel of wheat (the price of which is \$3). A price ratio like P_W/P_C always denotes the relative price of the good in the numerator (wheat, in this case), measured in terms of how much of the good in the denominator (cloth) must be given up. In Figure 2-2, the slope of the PPF equals the relative price of wheat, the good on the *horizontal* axis.

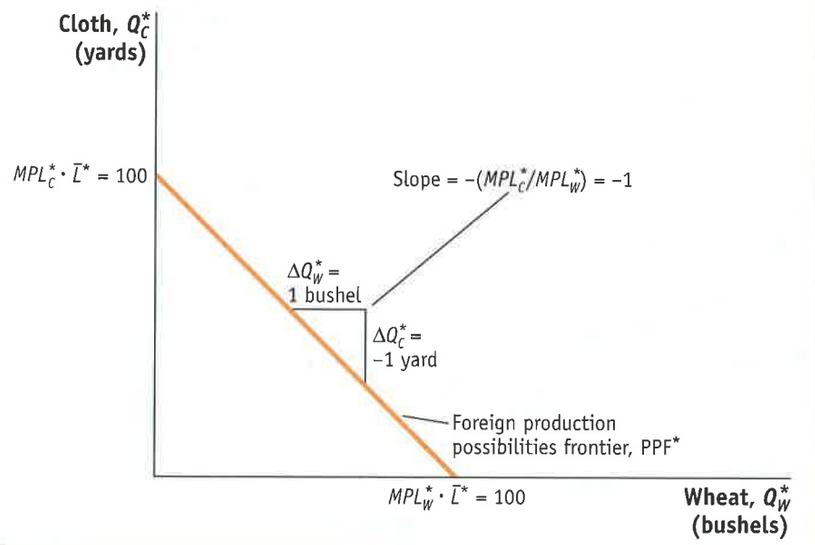
The Foreign Country

Now let's introduce another country, Foreign, into the model. We will assume that Foreign's technology is inferior to Home's so that it has an absolute *disadvantage* in producing both wheat and cloth as compared with Home. Nevertheless, once we introduce international trade, we will still find that Foreign will trade with Home.

Foreign Production Possibilities Frontier Suppose that one Foreign worker can produce 1 bushel of wheat ($MPL^*_W = 1$), or 1 yard of cloth ($MPL^*_C = 1$), whereas recall that a Home worker can produce 4 bushels of wheat or 2 yards of cloth. Suppose that there are $\overline{L}^* = 100$ workers available in the Foreign country. If all these workers were employed in wheat, they could produce $MPL^*_W \cdot \overline{L}^* = 100$ bushels, and if they were all employed in cloth, they could produce $MPL^*_C \cdot \overline{L}^* = 100$ yards. Foreign's production possibilities frontier (PPF) is thus a straight line between these two points, with a slope of −1, as shown in Figure 2-3.

You might find it helpful to think of the Home country in our example as the United States or Europe and the Foreign country as the "rest of the world." Empirical evidence supports the idea that the United States and Europe have the leading technologies in many goods and an absolute advantage in the production of both wheat and cloth. Nevertheless, they import much of their clothing and textiles from abroad, especially from Asia and Latin America. Why does the United States or Europe import these goods from

FIGURE 2-3



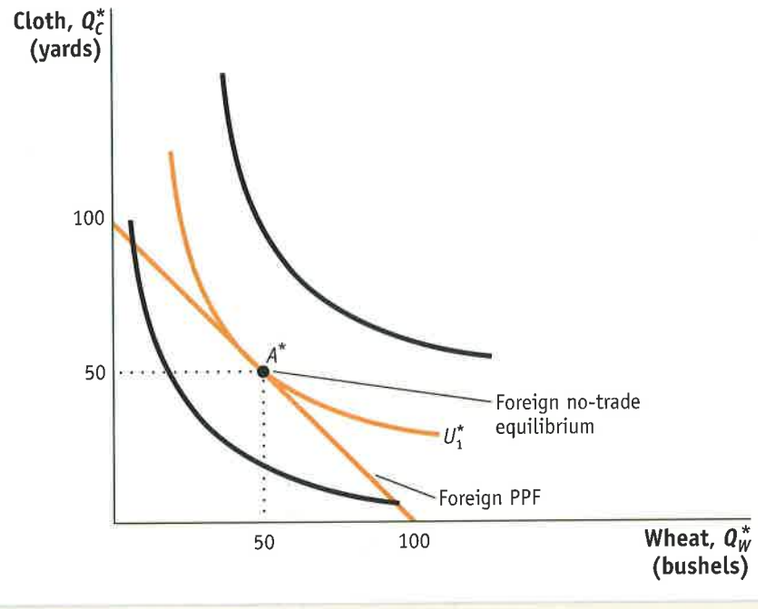
Foreign Production Possibilities Frontier
The Foreign PPF is a straight line between 100 yards of cloth and 100 bushels of wheat. The slope of the PPF equals the negative of the opportunity cost of wheat, that is, the amount of cloth that must be given up (1 yard) to obtain 1 more bushel of wheat.

abroad when they have superior technology at home? To answer this question, we want to focus on the *comparative advantage* of Home and Foreign in producing the two goods.

Comparative Advantage In Foreign, it takes one worker to produce 1 bushel of wheat or 1 yard of cloth. Therefore, the opportunity cost of producing 1 yard of cloth is 1 bushel of wheat. In Home, one worker produces 2 yards of cloth or 4 bushels of wheat. Therefore, Home's opportunity cost of a bushel of wheat is $\frac{1}{2}$ a yard of cloth, and its opportunity cost of a yard of cloth is 2 bushels of wheat. Based on this comparison, Foreign has a *comparative advantage in producing cloth* because its opportunity cost of cloth (which is 1 bushel of wheat) is *lower* than Home's opportunity cost of cloth (which is 2 bushels of wheat). Conversely, Home has a *comparative advantage in producing wheat* because Home's opportunity cost of wheat (which is $\frac{1}{2}$ yard of cloth) is lower than Foreign's (1 yard of cloth). In general, a country has a comparative advantage in a good when it has a lower opportunity cost of producing it than does the other country. Notice that Foreign has a comparative advantage in cloth even though it has an absolute disadvantage in both goods.

As before, we can represent Foreign's preferences for wheat and cloth with indifference curves like those shown in Figure 2-4. With competitive markets, the economy will produce at the point of highest utility for the country, point A^*, which is the no-trade equilibrium in Foreign. The slope of the PPF, which equals the opportunity cost of wheat, also equals the relative price of wheat.[4] Therefore, in Figure 2-4, Foreign's no-trade relative price of wheat is $P_W^*/P_C^* =$

FIGURE 2-4



Foreign Equilibrium with No Trade The highest level of Foreign utility on the PPF is obtained at point A^*, which is the no-trade equilibrium.

1. Notice that this relative price *exceeds* Home's no-trade relative price of wheat, which is $P_W/P_C = \frac{1}{2}$. This difference in these relative prices reflects the comparative advantage that Home has in the production of wheat.[5]

APPLICATION

Comparative Advantage in Apparel, Textiles, and Wheat

The U.S. textile and apparel industries face intense import competition, especially from Asia and Latin America. Employment in this industry in the United States fell from about 1.5 million people in 1990 to less than 1 million in 1999. An example of this import competition can be seen from one U.S. fabric manufacturer, Burlington Industries, which announced in January 1999 that it would reduce its production capacity by 25% because of increased imports from Asia. Burlington closed seven plants and laid off 2,900 people, about 17% of its domestic force. After the layoffs, Burlington Industries employed 17,400 people in the United States. With 1999 sales of $1.6 billion, this means that its sales per employee were $1.6 billion/17,400 = $92,000 per worker. This is exactly at the average for all U.S. apparel producers, as shown in Table 2-2. The textile industry, producing the fabric and material inputs for

TABLE 2-2

Apparel, Textiles, and Wheat in the United States and China This table shows sales per employee for the apparel and textile industries in the United States and China, as well as bushels per hour in producing wheat. The United States has an absolute advantage in all of these products (as shown by the numbers in the right-hand column of the table), but it has a comparative advantage in producing wheat (as shown at the numbers in the bottom rows of the table).

	United States	China	Absolute Advantage
	Sales/Employee	*Sales/Employee*	*U.S./China Ratio*
Apparel	$92,000	$13,500	7
Textiles	$140,000	$9,000	16
	Bushels/Hour	*Bushels/Hour*	*U.S./China Ratio*
Wheat	27.5	0.1	275
	Comparative Advantage		
Wheat/Apparel Ratio × 1,000	0.3	0.01	
Wheat/Textile Ratio × 1,000	0.2	0.01	

Note: Data are for years around 1995.

Source: Wheat data from Colin Carter, University of California, Davis; apparel/textiles data from various sources.

[4] Remember that the slope of the PPF (ignoring the minus sign) equals the relative price of the good on the *horizontal* axis—wheat in Figure 2-4. Foreign has a steeper PPF than Home as shown in Figure 2-2, so Foreign's relative price of wheat is higher than Home's. The inverse of the relative price of wheat is the relative price of cloth, which is lower in Foreign.

[5] Taking the reciprocal of the relative price of wheat in each country, we also see that Foreign's no-trade relative price of cloth is $P_C^*/P_W^* = 1$, which is less than Home's no-trade relative price of cloth, $P_C/P_W = 2$. Therefore, Foreign has a comparative advantage in cloth.

apparel, is even more productive, with annual sales per employee of $140,000 in the United States.

In comparison, the average worker in China produces $13,500 of sales per year in the apparel industry and $9,000 in the textile industry. Thus, a worker in the United States produces $92,000/$13,500 = 7 times more apparel sales than a worker in China and $140,000/$9,000 = 16 times more textile sales. This ratio is shown in Table 2-2 in the column labeled "Absolute Advantage." It illustrates how much more productive U.S. labor is in these industries relative to Chinese labor. The United States clearly has an absolute advantage in both of these industries, so why does it import so much of its textiles and apparel from Asia, including China?

The answer can be seen by also comparing the productivities in the wheat industry. The typical wheat farmer in California devotes only 1.35 hours per acre to growing a crop of wheat, and an acre provides 37 bushels of wheat, a marginal product of 37/1.35 = 27.5 bushels per hour of labor. In comparison, the typical wheat farmer in China obtains only one-tenth of a bushel per hour of labor, so the U.S. farmer is 27.5/0.1 = 275 times more productive! The United States clearly has an *absolute advantage* in all of these industries.

But China has the *comparative advantage* in both apparel and textiles, as illustrated by the rows labeled "Comparative Advantage." To keep the calculations simple, suppose that a farmer spends 1,000 hours per year growing a crop of wheat. Multiplying the marginal product of an hour of labor in wheat by 1,000, to obtain the marginal product of labor per year, and dividing by the marginal product of labor in apparel, gives us the *opportunity cost of apparel*. In the United States, for example, this ratio is 27,500/92,000 = 0.3 bushels/$, indicating that 0.3 bushels of wheat must be foregone to obtain an extra dollar of sales in apparel. In textiles, the U.S. ratio is 27,500/140,000 = 0.2 bushels/$, so that 0.2 bushels of wheat must be foregone to obtain an extra dollar in textile sales. But these ratios are much smaller in China: only 100/13,500 or 100/9,000 ≈ 0.01 bushels of wheat must be foregone to obtain one dollar extra sales in either textiles or apparel. As a result, China has a lower opportunity cost of both textiles and apparel than the United States, which explains why it exports those goods, while the United States exports wheat, just as predicted by the Ricardian model. ■

3 Determining the Pattern of International Trade

Now that we have examined each country in the absence of trade, we can start to analyze what happens when goods are traded between them. We will see that a country's no-trade relative price determines which product it will export and which it will import when trade is opened. As we have shown earlier, the no-trade relative price in each country equals its opportunity cost of producing that good. Therefore, the pattern of exports and imports will be determined by the opportunity costs of production in each country, or by each country's pattern of comparative advantage. This section examines why this is the case and details each country's choice of how much to produce, consume, and trade of each good.

SIDE BAR

Can Comparative Advantage Be Created? The Case of "Icewine"

Recall that in Ricardo's original example of trade between Portugal and England, he gave Portugal an absolute advantage in both wine and cloth, based on its favorable climate. England would find it very difficult to grow grapes for wine and not so difficult to produce cloth, so it had a comparative advantage in cloth. This raises the question: What if a new technology could be discovered that would allow England to produce world-class grapes and wine? Would it be possible for it to create a new comparative advantage in wine?

Alamy

Snow-covered grapes harvested to make icewine.

Something like this occurred in the Niagara Falls region of Canada, which sells a product called "icewine." First developed in Germany in 1794 (when Ricardo was 21 years old), icewine is produced by allowing the grapes to freeze on the vine. Freezing concentrates the sugars and flavors of the grapes, which are picked by hand and then processed into a sweet dessert wine. In 1983 several wineries in the Niagara Falls region of Canada experimented with producing this wine, and it has since taken off to become a local specialty. The cold climate of Niagara Falls offers an advantage in producing icewine, since the temperature should be −10°C to −13°C before picking. The yield from this process is very low—an entire vine might make only one bottle—which is why it is sold in half-bottles. But demand is high because of the unique flavor of this wine, and the half-bottles often sell for $50 or more. Icewine is now also being produced in the Okanagan Valley region of British Columbia, Canada, which also enjoys a climate warm enough in the summer to grow grapes and cold enough in the winter to freeze them. Will England ever be able to develop this wine? If so, the comparative advantage between England and Portugal in Ricardo's original model might be reversed!

International Trade Equilibrium

The differences in no-trade prices across the countries create an opportunity for international trade between them. In particular, producers of cloth in Foreign, where the relative price of cloth is $P_C^*/P_W^* = 1$, would want to export cloth to Home, where the relative price, $P_C/P_W = 2$, is higher. Conversely, producers of wheat in Home, where the relative price of wheat is $P_W/P_C = \frac{1}{2}$, would want to export wheat to Foreign, where the relative price of $P_W^*/P_C^* = 1$ is higher. The trade pattern that we expect to arise, then, is that *Home will export wheat,* and *Foreign will export cloth*. Notice that both countries export the good in which they have a comparative advantage, which is what the Ricardian model predicts.

To solidify our understanding of this trade pattern, let's be more careful about explaining where the two countries would produce on their PPFs under international trade and where they will consume. As Home exports wheat, the quantity of wheat sold at Home falls, and this condition bids up the price of wheat in the Home market. As the exported wheat arrives in the Foreign wheat market, more wheat is sold there, and the price of wheat in the Foreign market falls. Likewise, as Foreign exports cloth, the price of cloth in Foreign will be bid up and the price of cloth in Home will fall. The two countries are in an **international trade equilibrium,** or just **trade equilibrium,** for short, when the relative price of wheat is the same in the

two countries, which means that the relative price of cloth is also the same in both countries.[6]

To fully understand the international trade equilibrium, we are interested in two issues: (i) determining the relative price of wheat (or cloth) in the trade equilibrium and (ii) seeing how the shift from the no-trade equilibrium to the trade equilibrium affects production and consumption in both Home and Foreign. Addressing the first issue requires some additional graphs, so let's delay this discussion for a moment and suppose for now that the relative price of wheat in the trade equilibrium is established at a level between the pretrade prices in the two countries. This assumption is consistent with the bidding up of export prices and bidding down of import prices, as discussed previously. Since the no-trade prices were $P_W/P_C = \frac{1}{2}$ in Home and $P_W^*/P_C^* = 1$ in Foreign, let's suppose that the world relative price of wheat is between these two values, say at $\frac{2}{3}$. Given the change in relative prices from their pretrade level to the international trade equilibrium, what happens to production and consumption in each of the two countries?

Change in Production and Consumption The world relative price of wheat that we have assumed is higher than Home's pretrade price $\left(\frac{2}{3} > \frac{1}{2}\right)$. This relationship between the pretrade and world relative prices means that Home producers of wheat can earn more than the opportunity cost of wheat (which is $\frac{1}{2}$) by selling their wheat to Foreign. For this reason, Home will shift its labor resources toward the production of wheat and produce more wheat than it did in the pretrade equilibrium (point A in Figure 2-5). To check that this intuition is correct, let us explore the incentives for labor to work in each of Home's industries.

Recall that Home wages paid in the wheat industry equal $P_W \cdot MPL_W$, and wages paid in the cloth industry equal $P_C \cdot MPL_C$. We know that the relative price of wheat in the trade equilibrium is $P_W/P_C = \frac{2}{3}$, that the marginal product of labor in the Home wheat industry is $MPL_W = 4$, and that the marginal product of labor in the Home cloth industry is $MPL_C = 2$. We can plug these numbers into the formulas for wages to compute the *ratio* of wages in the two industries as

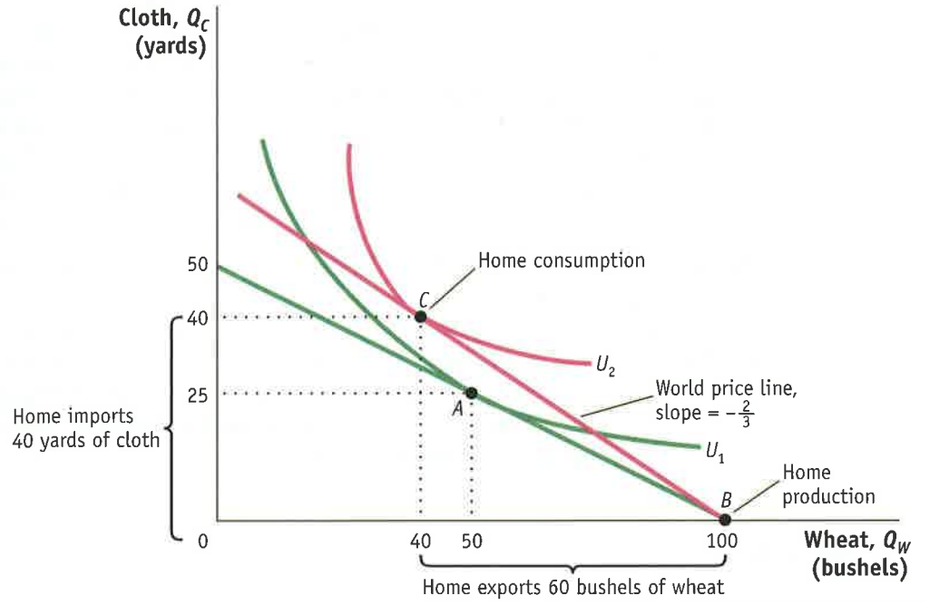
$$\frac{P_W \cdot MPL_W}{P_C \cdot MPL_C} = \left(\frac{2}{3}\right)\left(\frac{4}{2}\right) = \frac{8}{6} > 1, \text{ so that } P_W \cdot MPL_W > P_C \cdot MPL_C$$

This formula tells us that with the world relative price of wheat of $\frac{2}{3}$, wages paid in Home's wheat industry ($P_W \cdot MPL_W$) are greater than those paid in its cloth industry ($P_C \cdot MPL_C$). Accordingly, all of Home's workers will want to work in the wheat industry, and no cloth will be produced. With trade, the Home economy will be fully specialized in wheat production, as occurs at production point B in Figure 2-5.[7]

[6] Notice that if the relative price of wheat, P_W/P_C, is the same in the two countries, then so is the relative price of cloth, which is just its inverse and equal to P_C/P_W.

[7] The fully specialized economy (producing only wheat) is a special feature of the Ricardian model because of its straight-line production possibilities frontier.

FIGURE 2-5



Home Equilibrium with Trade With a world relative price of wheat of $\frac{2}{3}$, Home production will occur at point B. Through international trade, Home is able to export each bushel of wheat it produces in exchange for $\frac{2}{3}$ yard of cloth. As wheat is exported, Home moves up the world price line BC. Home consumption occurs at point C, at the tangent intersection with indifference curve U_2, since this is the highest possible utility curve on the world price line. Given these levels of production and consumption, we can see that total exports are 60 bushels of wheat in exchange for imports of 40 yards of cloth and also that Home consumes 10 fewer bushels of wheat and 15 more yards of cloth relative to its pretrade levels.

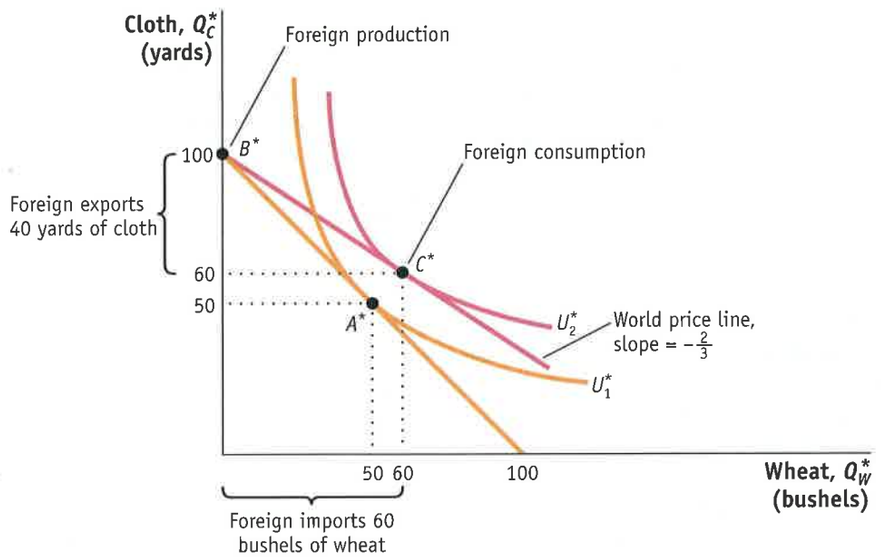
International Trade Starting at the production point B, Home can export wheat at a relative price of $\frac{2}{3}$. This means that for 1 bushel of wheat exported to Foreign, it receives $\frac{2}{3}$ yards of cloth in exchange. In Figure 2-5, we can trace out its international trades by starting at point B and then exchanging 1 bushel of wheat for $\frac{2}{3}$ yards of cloth, another bushel of wheat for $\frac{2}{3}$ yard of cloth, and so on. From point B, this traces out the line toward point C, with slope $-\frac{2}{3}$. We will call the line starting at point B (the production point) and with a slope equal to the negative of the world relative price of wheat, the **world price line,** as shown by BC. The world price line shows the range of *consumption possibilities* that a country can achieve by specializing in one good (wheat, in Home's case) and engaging in international trade (exporting wheat and importing cloth). We can think of the world price line as a new budget constraint for the country under international trade.

Notice that this budget constraint (the line BC) lies *above* Home's original PPF. The ability to engage in international trade creates consumption

possibilities for Home that were not available in the absence of trade, when the consumption point had to be on Home's PPF. Now, Home can choose to consume at any point on the world price line, and utility is maximized at the point corresponding to the intersection with the highest indifference curve, labeled C with utility of U_2. Home obtains a higher utility with international trade than in the absence of international trade (U_2 is higher than U_1); the finding that Home's utility increases with trade is our first demonstration of the **gains from trade,** by which we mean the ability of a country to obtain higher utility for its citizens under free trade than with no trade.

Pattern of Trade and Gains from Trade Comparing production point B with consumption point C, we see that Home is exporting $100 - 40 = 60$ bushels of wheat, in exchange for 40 yards of cloth imported from Foreign. If we value the wheat at its international price of $\frac{2}{3}$, then the value of the exported wheat is $\frac{2}{3} \cdot 60 = 40$ yards of cloth, and the value of the imported cloth is also 40 yards of cloth. Because Home's exports equal its imports, this outcome shows that Home's trade is balanced.

FIGURE 2-6



Foreign Equilibrium with Trade With a world relative price of wheat of $\frac{2}{3}$, Foreign production will occur at point B^*. Through international trade, Foreign is able to export $\frac{2}{3}$ yard of cloth in exchange for 1 bushel of wheat, moving down the world price line B^*C^*. Foreign consumption occurs at point C^*, and total exports are 40 yards of cloth in exchange for imports of 60 bushels of wheat. Relative to its pretrade wheat and cloth consumption (point A^*), Foreign consumes 10 more bushels of wheat and 10 more yards of cloth.

What happens in Foreign when trade occurs? Foreign's production and consumption points are shown in Figure 2-6. The world relative price of wheat $\left(\frac{2}{3}\right)$ is less than Foreign's pretrade relative price of wheat (which is 1). This difference in relative prices causes workers to leave wheat production and move into the cloth industry. Foreign specializes in cloth production at point B^*, and from there, trades along the world price line with a slope of (negative) $\frac{2}{3}$, which is the relative price of wheat. That is, Foreign exchanges $\frac{2}{3}$ yard of cloth for 1 bushel of wheat, $\frac{2}{3}$ yards of cloth for 1 bushel of wheat, and so on, as it moves down the world price line B^*C^*. The consumption point that maximizes Foreign's utility is C^*, at which point 60 units of each good are consumed and utility is U_2^*. Foreign's utility is greater than it was in the absence of international trade (U_2^* is a higher indifference curve than U_1^*) as is true for Home. Therefore, both countries gain from trade.

Foreign produces 100 yards of cloth at point B^*: it consumes 60 yards itself and exports $100 - 60 = 40$ yards of cloth in exchange for 60 bushels of wheat imported from Home. This trade pattern is exactly the opposite of Home's, as must be the case. In our two-country world, everything leaving one country must arrive in the other. We see that Home is exporting wheat, in which it has a comparative advantage (Home's opportunity cost of wheat production is $\frac{1}{2}$ yard of cloth compared with 1 yard in Foreign). Furthermore, Foreign is exporting cloth, in which it has a comparative advantage (Foreign's opportunity cost of cloth production is 1 bushel of wheat compared with 2 bushels in Home). This outcome confirms that *the pattern of trade is determined by comparative advantage,* which is the first lesson of the Ricardian model. We have also established that there are *gains from trade for both countries,* which is the second lesson.

These two conclusions are often where the Ricardian model stops in its analysis of trade between countries, but the story is incomplete because we have not yet determined the level of wages across countries. We have seen that with trade, the relative price of each good converges to a single equilibrium price in both countries. Does the same occur with wages? As we now show, this is not the case. Wage levels differ across countries with trade, and wages are determined by *absolute* advantage, not *comparative* advantage. This is a third, less emphasized lesson from the Ricardian model, which we explore next.

Solving for Wages across Countries

To understand how wages are determined, we go back to microeconomics. In competitive labor markets, firms will pay workers the value of their marginal product. Home produces and exports wheat, so we can think of Home workers being paid in terms of that good: their real wage is $MPL_W = 4$ bushels of wheat. We refer to this payment as a "real" wage because it is measured in terms of a good that workers consume and not in terms of money. The workers can then sell the wheat they earn on the world market at the relative price of $P_W/P_C = \frac{2}{3}$. Thus, their real wage in terms of

units of cloth is $(P_W/P_C) \cdot MPL_W = \frac{2}{3} \cdot 4 = \frac{8}{3}$ yards. Summing up, the Home wage is[8]

$$\text{Home wage} = \begin{cases} MPL_W = 4 \text{ bushels of wheat} \\ \text{or} \\ (P_W/P_C) \cdot MPL_W = \dfrac{8}{3} \text{ yards of cloth} \end{cases}$$

What happens to Foreign wages? Foreign produces and exports cloth, and the real wage is $MPL_C^* = 1$ yard of cloth. Because cloth workers can sell the cloth they earn for wheat on the world market at the price of $\frac{3}{2}$, their real wage in terms of units of wheat is $(P_C^*/P_W^*) \cdot MPL_C^* = \left(\frac{3}{2}\right) \cdot 1 = \frac{3}{2}$ bushels. Thus, the Foreign wage is[9]

$$\text{Foreign wage} = \begin{cases} (P_C^*/P_W^*) \cdot MPL_C^* = \dfrac{3}{2} \text{ bushels of wheat} \\ \text{or} \\ MPL_C^* = 1 \text{ yard of cloth} \end{cases}$$

Foreign workers earn less than Home workers as measured by their ability to purchase either good. This fact reflects Home's absolute advantage in the production of both goods.

Absolute Advantage As our example shows, wages are determined by absolute advantage: Home is paying higher wages because it has better technology in both goods. In contrast, the pattern of trade in the Ricardian model is determined by comparative advantage. Indeed, these two results go hand in hand—the only way that a country with poor technology can export at a price others are willing to pay is by having low wages.

This statement might sound like a pessimistic assessment of the ability of less developed countries to pay reasonable wages, but it carries with it a silver lining: as a country develops its technology, its wages will correspondingly rise. In the Ricardian model, a logical consequence of technological progress is that workers will become better off through receiving higher wages. In addition, as countries engage in international trade, the Ricardian model predicts that their real wages will rise.[10] We do not have to look very hard to see examples of this outcome in the world. Per-capita income in China in 1978, just as it began to open up to international trade, is estimated to have been $925, whereas by 2000, per-capita income in China had risen by four times to $3,750. Likewise for India, per-capita income more than doubled from $1,180

[8] Recall that without international trade, Home wages were $MPL_W = 4$ bushels of wheat or $MPL_C = 2$ yards of cloth. Home workers are clearly better off with trade because they can afford to buy the same amount of wheat as before (4 bushels) but more cloth ($\frac{8}{3}$ yards instead of 2 yards). This is another way of demonstrating the gains from trade.

[9] Without international trade, Foreign wages were $MPL_W^* = 1$ bushel of wheat or $MPL_C^* = 1$ yard of cloth. Foreign workers are also better off with trade because they can afford to buy the same amount of cloth (1 yard) but more wheat ($\frac{3}{2}$ bushels instead of 1 bushel).

[10] That result is shown by the comparison of real wages in the trade equilibrium as compared with the no-trade equilibrium in each country, as is done in the previous two footnotes.

in 1978 to $2,480 in 2000.[11] Many people believe that the opportunity for these countries to engage in international trade has been crucial in raising their standard of living. As our study of international trade proceeds, we will try to identify the conditions that have allowed China, India, and many other developing countries to improve their standards of living through trade.

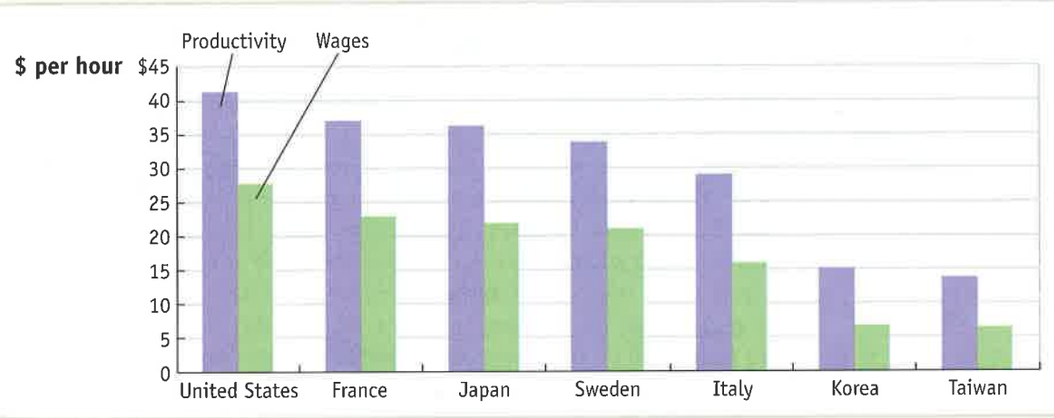
APPLICATION

Labor Productivity and Wages

The close connection between wages and labor productivity is evident by looking at data across countries. Labor productivity can be measured by the *value-added per hour* in manufacturing. Value-added is the difference between sales revenue in an industry and the costs of intermediate inputs (for example, the difference between the value of a car and the cost of all the parts used to build it). Value-added then equals the payments to labor and capital in an industry. In the Ricardian model, we ignore capital, so we can measure labor productivity as value-added divided by the number of hours worked, or value-added per hour.

In Figure 2-7, we show the value-added per hour in manufacturing in 2001 for several different countries. The United States has the highest level of productivity and Taiwan has the lowest for the countries shown. Figure 2-7 also shows the wages per hour paid in each country. These are somewhat less than

FIGURE 2-7

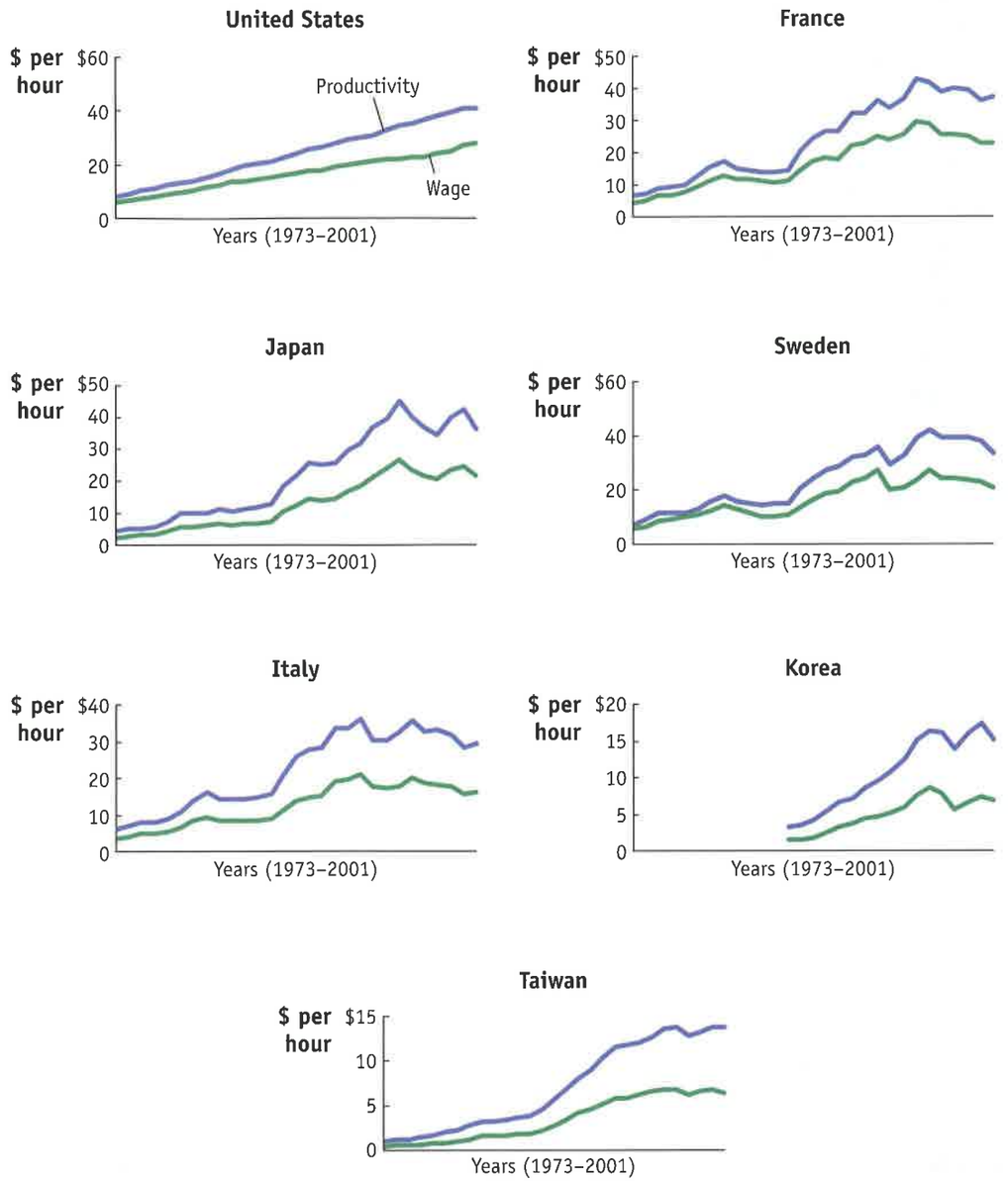


Labor Productivity and Wages, 2001 Labor productivity is measured by value-added per hour of work and can be compared with the wages paid in manufacturing in various countries. The general ranking of countries—from highest to lowest—in terms of labor productivity is the same as the ranking in terms of wages: countries with higher labor productivity pay higher wages, just as the Ricardian model predicts.

Source: U.S. Department of Labor, Bureau of Labor Statistics.

[11] These values are expressed in 1996 dollars and are taken from the Penn World Table, pwt.econ.upenn.edu.

FIGURE 2-8



Labor Productivity and Wages over Time The trends in labor productivity and wages can also be graphed over time. The general upward movement in labor productivity is matched by upward movements in wages, as predicted by the Ricardian model.

Source: U.S. Department of Labor, Bureau of Labor Statistics.

value-added per hour because value-added is also used to pay capital, but the general ranking of countries—from highest to lowest—in terms of labor productivity is the same as the ranking in terms of wages: countries with higher labor productivity pay higher wages, just as the Ricardian model predicts. The close connection between productivity and wages is also evident if we look at countries over time. These graphs are shown in Figure 2-8. We can see that the general upward movement in labor productivity is matched by upward movement in wages, as the Ricardian model predicts. ■

4 Solving for International Prices

In Figures 2-5 and 2-6, we assumed that the world relative price of wheat was $\frac{2}{3}$ and that at this level Home's exports of wheat just equaled Foreign's imports of wheat (and vice versa for cloth). Now we will dig a little deeper to show how the world price is determined.

To determine the world relative price of wheat, we will use supply and demand curves. Home exports wheat, so we will derive a Home **export supply curve,** which shows the amount it wants to export at various relative prices. Foreign imports wheat, so we will derive a Foreign **import demand curve,** which shows the amount of wheat that it will import at various relative prices. The international trade equilibrium is the quantity and relative price at which Home exports equal Foreign imports of wheat. This equality occurs where the Home export supply curve intersects the Foreign import demand curve.

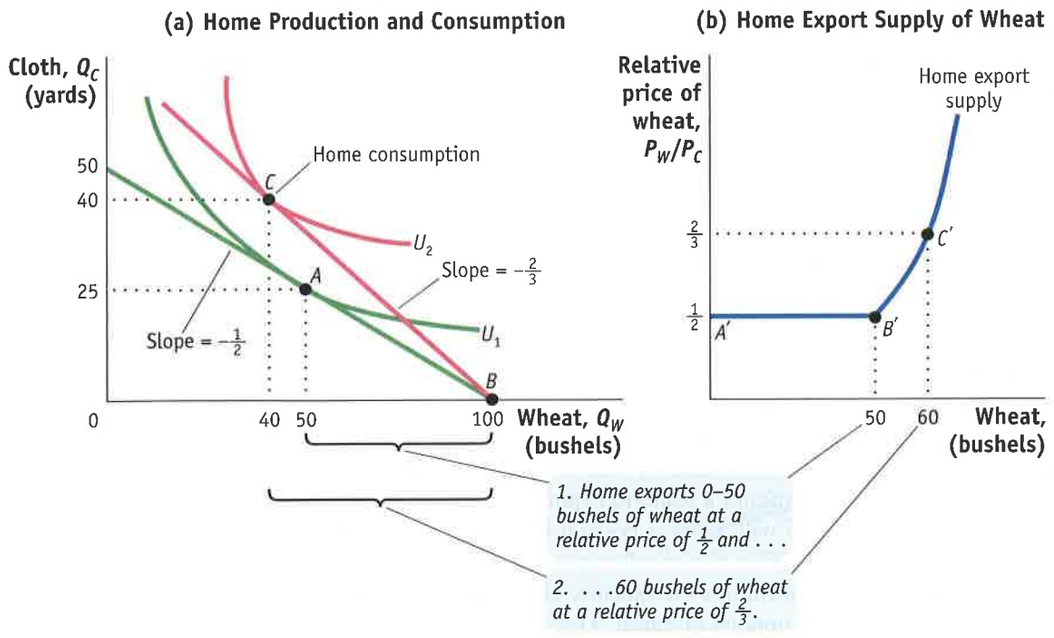
Home Export Supply Curve

In panel (a) of Figure 2-9, we repeat Figure 2-5, which shows the trade equilibrium for Home with production at point B and consumption at point C. At the world relative price of $P_W/P_C = \frac{2}{3}$, Home exports 60 bushels of wheat (the difference between wheat production of 100 and consumption of 40). We can use these numbers to construct a new graph, the Home export supply curve of wheat, shown in panel (b). The vertical axis in panel (b) measures the relative price of wheat and the horizontal axis measures the exports of wheat. The points B and C in panel (a), with the relative price of $P_W/P_C = \frac{2}{3}$ and Home exports of 60 bushels of wheat, now appear as point C' in panel (b), with $P_W/P_C = \frac{2}{3}$ on the vertical axis and Home wheat exports of 60 bushels on the horizontal axis. This is our first point on the Home export supply curve.

To derive other points on the export supply curve, consider the no-trade equilibrium in panel (a), which is shown by production and consumption at point A. The no-trade relative price of wheat is $\frac{1}{2}$ (the slope of Home's PPF), and Home exports of wheat are zero because there is no international trade. So the point A in panel (a) can be graphed at point A' in panel (b), with a relative price of $P_W/P_C = \frac{1}{2}$ and zero Home exports of wheat. This gives us a second point on the Home export supply curve.

To get a third point, let us keep the relative price of wheat at $P_W/P_C = \frac{1}{2}$, as in the no-trade equilibrium, but now allow Home to export some wheat in

FIGURE 2-9



Home Export Supply Panel (a) repeats Figure 2-5 showing the trade equilibrium for Home with production at point B and consumption at point C. Panel (b) shows the Home export supply of wheat. When the relative price of wheat is $\frac{1}{2}$, Home will export any amount of wheat between 0 and 50 bushels, along the segment $A'B'$ of the Home export supply curve. For relative prices above $\frac{1}{2}$, Home exports more than 50 bushels, along the segment $B'C'$. For example, at the relative price of $\frac{2}{3}$, Home exports 60 bushels of wheat.

exchange for cloth at this price. Home consumption remains at point A in panel (a), but production can shift from that point. The reason that production can shift to another point on the PPF is that, with the relative price $P_W/P_C = \frac{1}{2}$, the wages of workers are equal in wheat and cloth. This result was shown in our earlier discussion. With wages equal in the two industries, workers are willing to shift between them, so any point on the PPF is a possible production point. Consider, for example, production at point B in panel (a), where all workers have shifted into wheat and no cloth is produced. With the relative price $P_W/P_C = \frac{1}{2}$, consumption is still at point A, so the difference between points A and B is the amount of wheat that Home is exporting and the amount of cloth Home is importing. That is, Home exports 50 bushels of wheat (the difference between production of 100 and consumption of 50) and imports 25 yards of cloth (the difference between production of 0 and consumption of 25). Therefore, the relative price of $P_W/P_C = \frac{1}{2}$, with wheat exports of 50, is another point on the Home export supply curve, shown by B' in panel (b).

Joining up points A', B', and C′, we get a Home export supply curve that is flat between A' and B', and then rises between B' and C′ and beyond. The flat portion of the export supply curve is a special feature of the Ricardian model that occurs because the PPF is a straight line. That is, with the relative price of $P_W/P_C = \frac{1}{2}$, production can occur anywhere along the PPF as workers shift between industries; meanwhile, consumption is fixed at point A, leading to all the export levels between A' and B' in panel (b). As the relative price of wheat rises above $\frac{1}{2}$, production remains fixed at point B in panel (a), but the consumption point changes, rising above point A. With the relative price $P_W/P_C = \frac{2}{3}$, for example, consumption is at point C. Then Home exports of wheat are calculated as the difference between production at B and consumption at C. Graphing the various relative prices above $\frac{1}{2}$ and the bushels of wheat exported at each price, we get the upward-sloping Home export supply curve between B' and C′ in panel (b).

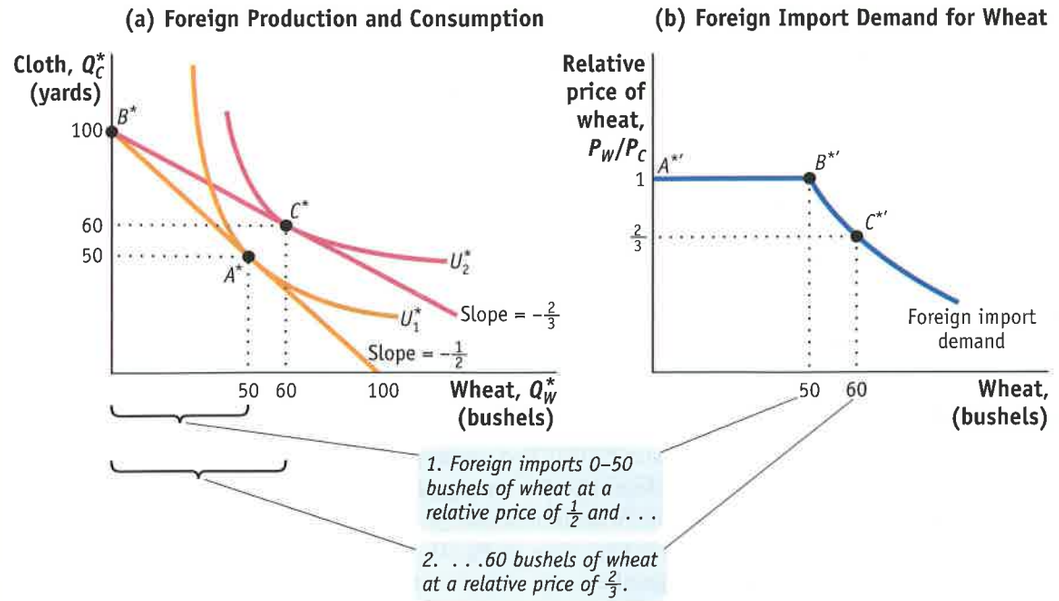
Foreign Import Demand Curve

In Foreign we will again focus on the wheat market and construct an import demand curve for wheat. In panel (a) of Figure 2-10, we repeat Figure 2-6, which shows the Foreign trade equilibrium with production at point B^* and consumption at point C^*. At the world relative price of $P_W/P_C = \frac{2}{3}$, Foreign imports 60 bushels of wheat (the difference between wheat consumption of 60 and production of 0). These numbers are graphed as point $C^{*\prime}$ in panel (b), where we have the relative price of wheat on the vertical axis and the Foreign imports of wheat on the horizontal axis.

Other points on Foreign's import demand curve can be obtained in much the same way as we did for Home. For example, the no-trade equilibrium in Foreign is shown by production and consumption at point A^* in panel (a), with the relative price of wheat equal to 1 (the slope of Foreign's PPF) and zero imports (since there is no international trade). This no-trade equilibrium is graphed as point $A^{*\prime}$ in panel (b). Keeping the relative price of wheat fixed at 1 in Foreign, production can shift away from point A^* in panel (a). This can occur because, as we argued for Home, wages are the same in Foreign's wheat and cloth industries when the relative price is at its no-trade level, so workers are willing to move between industries. Keeping Foreign consumption fixed at point A^* in panel (a), suppose that all workers shift into the cloth industry, so that production is at point B^*. Then Foreign imports of wheat are 50 bushels (the difference between Foreign consumption of 50 and production of zero), as shown by point $B^{*\prime}$ in panel (b).

Joining up points $A^{*\prime}$, $B^{*\prime}$, and $C^{*\prime}$, we get an import demand curve that is flat between $A^{*\prime}$ and $B^{*\prime}$ and then falls between $B^{*\prime}$ and $C^{*\prime}$ and beyond. The flat portion of the Foreign import demand curve is once again a special feature of the Ricardian model that occurs because the PPF is a straight line. As we investigate other trade models in the following chapters, in which the production possibilities frontiers are curved rather

FIGURE 2-10



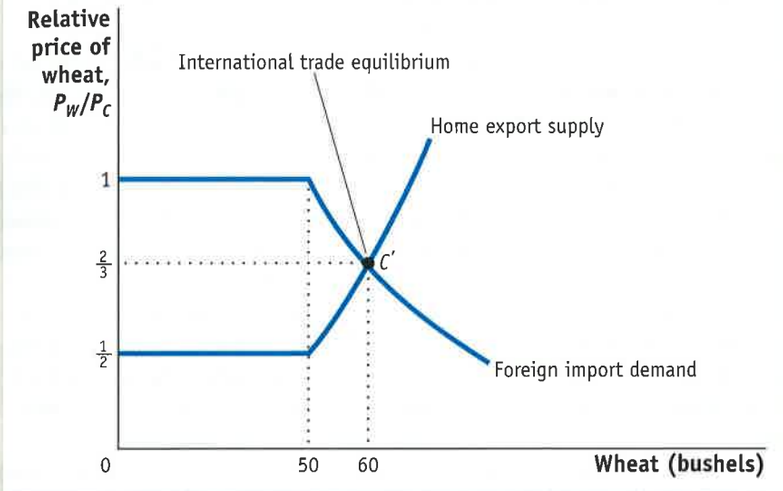
Foreign Import Demand Panel (a) repeats Figure 2-6, showing the Foreign trade equilibrium with production at point B^* and consumption at point C^*. Panel (b) shows Foreign import demand for wheat. When the relative price of wheat is 1, Foreign will import any amount of wheat between 0 and 50 bushels, along the segment $A^{*\prime}B^{*\prime}$ of the Foreign import demand curve. For relative prices below 1, Foreign imports more than 50 bushels, along the segment $B^{*\prime}C^{*\prime}$. For example, at the relative price of $\frac{2}{3}$, Foreign imports 60 bushels of wheat.

than straight lines, the export supply and import demand curves will no longer have the flat portions. A general feature of these export supply and import demand curves is that they begin at the no-trade relative price for each country and then slope up (for export supply) or down (for import demand).

International Trade Equilibrium

Now that we have derived the Home export supply curve and the Foreign import demand curve, we can put them together in a single diagram, shown in Figure 2-11. The intersection of these two curves at point C' gives the international trade equilibrium, the equilibrium relative price of wheat at which the quantity of Home exports just equals Foreign imports. In Figure 2-11, the equilibrium relative price of wheat is $P_W/P_C = \frac{2}{3}$. This graph looks just like the supply = demand equilibria that you have seen in other economics classes, except that Figure 2-11 now refers to the *world* market for wheat

FIGURE 2-11



World Market for Wheat Putting together the Home export supply curve and the Foreign import demand curve for wheat, the world equilibrium is established at point C', where the relative price of wheat is $\frac{2}{3}$. At this price, Home exports of 60 bushels just equal Foreign imports of wheat.

rather than the market in a single country. That is, Home's export supply of wheat is the *excess* of the total Home supply over the quantity demanded by Home consumers, whereas Foreign import demand is the *excess* of total Foreign demand over the quantity supplied by Foreign suppliers. The intersection of these excess supply and demand curves, or export supply and import demand curves in Figure 2-11, determines the relative price of wheat that clears the world market, that is, at which the desired sales of Home equal the desired purchases by Foreign.

The Terms of Trade The price of a country's exports divided by the price of its imports is called the **terms of trade.** Because Home exports wheat, (P_W/P_C) is its terms of trade. Notice that an increase in the price of wheat (Home's export) or a fall in the price of cloth (Home's import) would both *raise* its terms of trade. Generally, an increase in the terms of trade is good for a country because it is earning more for its exports or paying less for its imports, thus making it better off. Foreign exports cloth, so (P_C/P_W) is its terms of trade. In this case, having a higher price for cloth (Foreign's export) or a lower price for wheat (Foreign's import) would make the Foreign country better off.

APPLICATION

The Terms of Trade for Primary Commodities

What has happened over time to the terms of trade? Writing in the 1950s, the Latin American economist Raúl Prebisch and the British economist Hans Singer each put forward the hypothesis that the price of *primary commodities*

(that is, agricultural products and minerals) would decline over time relative to the price of manufactured goods. Because primary commodities are often exported by developing countries, this would mean that the terms of trade in developing countries would decline over time.

There are several reasons why the Prebisch-Singer hypothesis might be true. First, it is well known that as people or countries become richer, they spend a smaller share of their income on food.[12] This means that as world income grows, the demand for food will decline relative to the demand for manufactured goods. Therefore, the price of agricultural products can also be expected to decline relative to manufactured goods. Second, for mineral products, it may be that industrialized countries continually find substitutes for the use of minerals in their production of manufactured products. For example, much less steel is used in cars today because automobile producers have shifted toward the use of plastic and aluminum in the body and frame. We can think of the substitution away from mineral products as a form of technological progress, and as it proceeds, it can lead to a fall in the price of raw minerals.

However, there are also several reasons why the Prebisch-Singer hypothesis may not be true. First, technological progress in manufactured goods can certainly lead to a fall in the price of these goods as they become easier to produce (think of the reduction in prices of many electronic goods, such as MP3 and DVD players, for example). This is a fall in the terms of trade for industrialized countries rather than developing countries. Second, at least in the case of oil exports, the Organization of Petroleum Exporting Countries (OPEC) has managed to keep oil prices high by restricting supplies on the world market. This has resulted in an increase in the terms of trade for oil-exporting countries, which includes developing and industrialized countries.

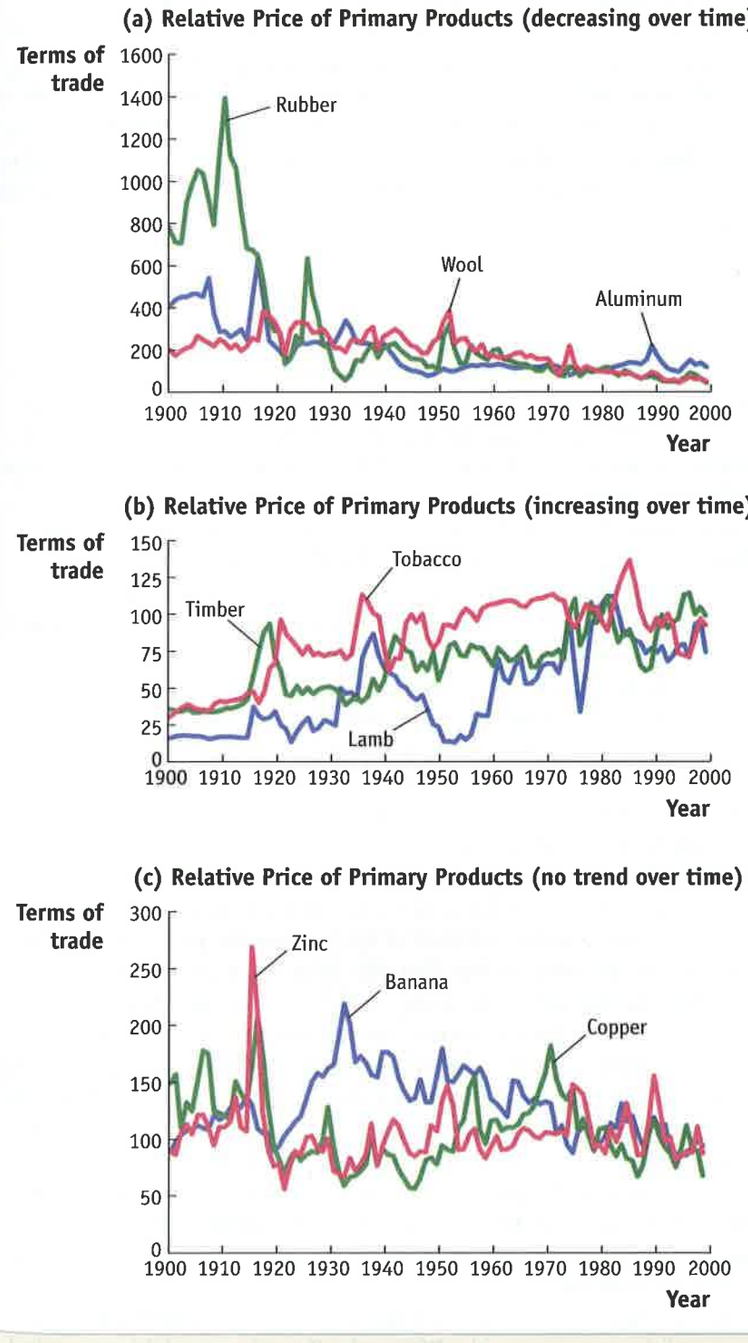
Data on the relative price of primary commodities are shown in Figure 2-12.[13] This study considered 24 primary commodities from 1900 to 1998 and measured their world price relative to the overall price of manufactured goods. Of the 24 commodities, one-half of them showed a decline in their relative price for 50% or more of the time period, including aluminum, cotton, hides, palm oil, rice, sugar, rubber, wheat, and wool. This evidence provides some support for the Prebisch-Singer hypothesis. Several examples of these commodities, with declining relative prices, are shown in panel (a) of Figure 2-12.

However, there are also a number of primary commodities whose prices increased for significant periods of time, or showed no consistent trend over the century. Commodities that had increasing relative prices for 50%

[12] This relationship is known as Engel's Law after the nineteenth-century German statistician Ernst Engel. It is certainly true for purchases of food eaten at home but might not hold for dining out. As your income rises, you might spend a constant or even increasing share of your budget on restaurant food.

[13] These results are provided by Neil Kellard and Mark E. Wohar, "Trends and Persistence in Primary Commodity Prices," *Journal of Development Economics,* 79, February 2006, 146–167.

FIGURE 2-12



Relative Price of Primary Commodities Many developing countries export primary commodities (that is, agricultural products and minerals), whereas industrial countries export manufactured products. Shown here are the prices of various primary commodities relative to an overall manufacturing price, from 1900 to 1998. The relative prices of some primary commodities have fallen over time (panel a), whereas other commodities have had rising relative prices (panel b). Other commodity prices show no consistent trend over time (panel c).

or more of the time period include beef, lamb, timber, tin, and tobacco. Several of these commodities are shown in panel (b) of Figure 2-12. Finally, commodities that had no consistent trend in their relative prices between the beginning and end of the century include bananas, coffee, copper, and zinc. Several of these are shown in panel (c) of Figure 2-12. From these results for different commodities, we should conclude that there are some that follow the pattern predicted by Prebisch and Singer, with falling prices relative to manufacturing. This is not a general rule, however, and other primary commodities have had increasing or no consistent change in their prices. ■

5 Conclusions

The Ricardian model was devised to respond to the mercantilist idea that exports are good and imports are bad. Not so, said David Ricardo, and to prove his point he considered an example in which trade between two countries (England and Portugal) is balanced; that is, the value of imports equals the value of exports for each country. The reason that England and Portugal trade with each other in Ricardo's example is that their technologies for producing wine and cloth are different. Portugal has an absolute advantage in both goods, but England has a comparative advantage in cloth. That is, the opportunity cost of producing cloth in England (measured by how much wine would have to be given up) is lower than in Portugal. Based on this comparative advantage, the no-trade relative price of cloth is also lower in England than in Portugal. When trade is opened, cloth merchants in England export to Portugal, where they can obtain a higher price, and wine vintners in Portugal export to England. Thus, the pattern of trade is determined by comparative advantage, and both countries gain from trade.

For simplicity, the Ricardian model is presented with just a single factor of production—labor. We have used a lesson from microeconomics to solve for wages as the marginal product of labor times the price of each good. It follows from this relationship that the ratio of wages across countries is determined by the marginal product of labor in the goods being produced and by the prices of those goods. Because wages depend on the marginal products of labor in each country, we conclude that wages are determined by absolute advantage—a country with better technology will be able to pay higher wages. In addition, wages depend on the prices prevailing on world markets for the goods exported by each country. We have defined the *terms of trade* as the price of a country's exports divided by the price of its imports. Generally, having higher terms of trade (because of high export prices or low import prices) will lead to higher real wages and therefore will benefit workers.

The fact that only labor is used in the Ricardian model makes it special. Because of this assumption, the PPF in the Ricardian model is a straight line,

and the export supply and import demand curves each have a flat segment. These special properties do not occur in other models we consider in the following chapters, where in addition to labor, industries will use capital and land. Once we allow for the more realistic assumption of several factors of production, the gains from trade become more complicated. Even if there are overall gains for a country, some factors of production might gain as other factors of production lose due to opening trade. That is the topic we explore in the next chapter.

KEY POINTS

1. A country has comparative advantage in producing a good when the opportunity cost of producing the good is lower than the opportunity cost of producing the good in another country.
2. The pattern of trade between countries is determined by comparative advantage. This means that even countries with poor technologies can export the goods in which they have comparative advantage.
3. All countries experience gains from trade. That is, the utility of an importing or exporting country is at least as high as it would be in the absence of international trade.
4. The level of wages in each country is determined by its absolute advantage, that is, by the amount the country can produce with its labor. This result explains why countries with poor technologies are still able to export: their low wages allow them to overcome their low productivity.
5. The equilibrium price of a good on the world market is determined at the point where the export supply of one country equals the import demand of the other country.
6. A country's terms of trade equals the price of its export good divided by the price of its import good. A rise in a country's terms of trade makes it better off because it is exporting at higher prices or importing at lower prices.

KEY TERMS

import, p. 27
export, p. 28
technology, p. 28
resources, p. 28
outsourcing, p. 28
proximity, p. 29
Ricardian model, p. 29
trade pattern, p. 29
free-trade area, p. 29
natural resources, p. 30
labor resources, p. 30
capital, p. 30
factors of production, p. 30
foreign direct investment, p. 30
absolute advantage, p. 31
comparative advantage, p. 31
marginal product of labor, p. 32
production possibilities frontier (PPF), p. 33
opportunity cost, p. 34
indifference curves, p. 34
utility, p. 34
relative price, p. 36
international trade equilibrium, p. 41
world price line, p. 43
gains from trade, p. 44
export supply curve, p. 48
import demand curve, p. 48
terms of trade, p. 53

PROBLEMS

1. At the beginning of the chapter, there is a brief quotation from David Ricardo; here is a longer version of what Ricardo wrote:

   > England may be so circumstanced, that to produce the cloth may require the labour of 100 men for one year; and if she attempted to make the wine, it might require the labour of 120 men for the same time. . . . To produce the wine in Portugal, might require only the labour of 80 men for one year, and to produce the cloth in the same country, might require the labour of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth. This exchange might even take place, notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England.

   Suppose that the amount of labor he describes can produce 1,000 yards of cloth or 1,000 bottles of wine, in either country. Then answer the following:

   a. What is England's marginal product of labor in cloth and in wine, and what is Portugal's marginal product of labor in cloth and in wine? Which country has absolute advantage in cloth, and in wine, and why?
   b. Use the formula $P_W/P_C = MPL_C/MPL_W$ to compute the no-trade relative price of wine in each country. Which country has comparative advantage in wine, and why?

2. Suppose that each worker in the Home country can produce three cars or two TVs. Assume that Home has four workers.
   a. Graph the production possibilities frontier for the Home country.
   b. What is the no-trade relative price of cars at Home?

3. Suppose that each worker in the Foreign country can produce two cars or three TVs. Assume that Foreign also has four workers.
   a. Graph the production possibilities frontier for the Foreign country.
   b. What is the no-trade relative price of cars in Foreign?
   c. Using the information provided in Problem 2 regarding Home, in which good does Foreign have a comparative advantage, and why?

4. Suppose that in the absence of trade, Home consumes nine cars and two TVs while Foreign consumes two cars and nine TVs. Add the indifference curve for each country to the figures in Problems 2 and 3. Label the production possibilities frontier (PPF), indifference curve (U_1), and the no-trade equilibrium consumption and production for each country.

5. Now suppose the world relative price of cars is $P_C/P_{TV} = 1$.
   a. What good will each country specialize in? Briefly explain why.
   b. Graph the new world price line for each country in the figures in Problem 4, and add a new indifference curve (U_2) for each country in the trade equilibrium.
   c. Label the exports and imports for each country. How does the amount of Home exports compare with Foreign imports?
   d. Does each country gain from trade? Briefly explain why or why not.

6. Answer the following questions using the information given by the accompanying table.

	Home Country	Foreign Country	Absolute Advantage
Number of bicycles produced per hour	4	2	?
Number of snowboards produced per hour	6	8	?
Comparative Advantage	?	?	

   a. Complete the table for this problem in the same manner as Table 2-2 in the chapter.
   b. Which country has an absolute advantage in the production of bicycles? Which country has an absolute advantage in the production of snowboards?
   c. What is the opportunity cost of bicycles in terms of snowboards at Home? What is the opportunity cost of bicycles in terms of snowboards in Foreign?

   d. Which product will Home export, and which product does Foreign export? Briefly explain why.

7. Assume that Home and Foreign produce two goods, TVs and cars, and use the information below to answer the following questions.

In the No-Trade Equilibrium

Home Country		Foreign Country	
$Wage_{TV} = 12$	$Wage_C = ?$	$Wage^*_{TV} = ?$	$Wage^*_C = 6$
$MPL_{TV} = 2$	$MPL_C = ?$	$MPL^*_{TV} = ?$	$MPL^*_C = 1$
$P_{TV} = ?$	$P_C = 4$	$P^*_{TV} = 3$	$P^*_C = ?$

   a. What is the marginal product of labor for TVs and cars in the Home country? What is the no-trade relative price of TVs at Home?
   b. What is the marginal product of labor for TVs and cars in the Foreign country? What is the no-trade relative price of TVs in Foreign?
   c. Suppose the world relative price of TVs in the trade equilibrium is $P_{TV}/P_C = 1$. Which good will each country export? Briefly explain why.
   d. In the trade equilibrium, what is the real wage at Home in terms of cars and in terms of TVs? How do these values compare with the real wage in terms of either good in the no-trade equilibrium?
   e. In the trade equilibrium, what is the real wage in Foreign in terms of TVs and in terms of cars? How do these values compare with the real wage in terms of either good in the no-trade equilibrium?
   f. In the trade equilibrium, do Foreign workers earn more or less than those at Home, measured in terms of their ability to purchase goods? Explain why.

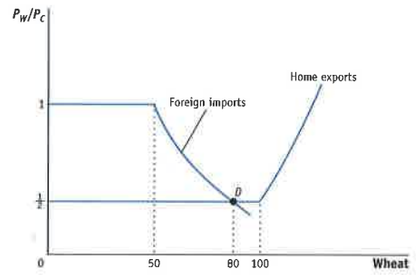
8. Why do some low-wage countries, such as China, pose a threat to manufacturers in industrial countries, such as the United States, while other low-wage countries, such as Haiti, do not?

   Answer Problems 9 to 11 using the chapter information for Home and Foreign:

9. a. Suppose that the number of workers doubles in Home. What happens to the Home PPF and what happens to the no-trade relative price of wheat?
   b. Suppose that there is technological progress in the wheat industry such that Home can produce more wheat with the same amount of labor. What happens to the Home PPF, and what happens to the relative price of wheat? Describe what would happen if a similar change occurred in the cloth industry.

10. a. Using Figure 2-5, show that an increase in the relative price of wheat from its world relative price of $\frac{2}{3}$ will raise Home's utility.
    b. Using Figure 2-6, show that an increase in the relative price of wheat from its world relative price of $\frac{2}{3}$ will lower Foreign's utility. What is Foreign's utility when the world relative price reaches 1, and what happens in Foreign when the world relative price of wheat rises above that level?

11. (*This is a harder question.*) Suppose that the Home country is much larger than the Foreign country. For example, suppose we double the number of workers at Home from 25 to 50. Then Home is willing to export up to 100 bushels of wheat at its no-trade price of $P_W/P_C = \frac{1}{2}$ rather than 50 bushels of wheat as shown in Figure 2-11. Following we draw a new version of Figure 2-11, with the larger Home country.



    a. From this figure, what is the new world relative price of wheat (at point *D*)?
    b. Using this new world equilibrium price, draw a new version of the trade equilibrium in Home and in Foreign, and show the production point and consumption point in each country.

c. Are there gains from trade in both countries? Explain why or why not.

12. Using the results from Problem 11, explain why the Ricardian model predicts that Mexico would gain more than the United States when the two countries signed the North American Free Trade Agreement, establishing free trade between them.

3

Gains and Losses from Trade in the Specific-Factors Model

It is the maxim of every prudent master of a family never to attempt to make at home what it will cost him more to make than to buy. . . . What is prudence in the conduct of every private family can scarce be folly in that of a great kingdom. If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry employed in a way in which we have some advantage.

Adam Smith, *The Wealth of Nations,* 1776

The time has come, the awaited day, a historic day in which Bolivia retakes absolute control of our natural resources.

Evo Morales, President of Bolivia, 2006[1]

Over the span of three years, 2003 to 2005, Bolivia had three presidents. This rapid succession at the highest level of government was largely a result of public dissatisfaction with the distribution of gains that had come from exporting natural gas. Many people, including the indigenous Aymara Indians, believed that most of these gains had gone to multinational oil corporations, with little distributed to the citizens of the country in which the gas deposits and refineries are located.

Violent protests in September 2003 led to the resignation of President Gonzalo Sánchez de Lozada, who was replaced by Carlos Mesa, a writer and television journalist. He promised to respect the views of the indigenous people of Bolivia and in July 2004 held a referendum on whether the country

[1] Speech from the San Alberto field operated by Petrobras, *USA Today,* "Bolivia Nationalizes Natural Gas Industry," May 1, 2006.