International Trade 4th edition Feenstra Solutions Manual

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2 Trade and Technology: The Ricardian Model

1. In this problem you will use the World Development Indicators (WDI) database from the World Bank to compute the comparative advantage of two countries in the major sectors of gross domestic product (GDP): agriculture, industry (which includes manufacturing, mining, construction, electricity, and gas), and services. Go to the WDI website at http://wdi.worldbank.org, and choose "Online tables," where you will be using the sections on "People" and on the "Economy."

   a. In the "People" section, start with the table "Labor force structure." Choose two countries that you would like to compare, and for a recent year write down their total labor force (in millions) and the percentage of the labor force that is female. Then calculate the number of the labor force (in millions) who are male and the number who are female.

Answer:

2014	Labor Force (million)	Female Labor (%)	Male Labor (million)	Female Labor (million)
France	30.1	47	15.95	14.15
Thailand	40.1	46	18.45	21.65

   b. Again using the "People" section of the WDI, now go to the "Employment by sector" table. For the same two countries that you chose in part (a) and for roughly the same year, write down the percent of male employment and the percent of female employment in each of the three sectors of GDP: agriculture, industry, and services. (If the data are missing in this table for the countries that you chose in part (a), use different countries.) Use these percentages along with your answer to part (a) to calculate the number of male workers and the number of female workers in each sector. Add together the number of male and female workers to get the total labor force in each sector.

Answer:

2011–2014	Agriculture		Industry		Service	
	Male %	Female %	Male %	Female %	Male %	Female %
France	4	2	31	10	65	88
Thailand	44	39	23	18	33	43

2011–2014 (million)	Agriculture		Industry		Service	
	Male	Female	Male	Female	Male	Female
France	0.64	0.28	4.95	1.42	10.37	12.45
Thailand	8.12	8.44	4.24	3.90	6.09	9.31

c. In the "Economy" section, go to the table "Structure of output." There you will find GDP (in $ billions) and the % of GDP in each of the three sectors: agriculture, industry, and services. For the same two countries and the same year that you chose in part (a), write down their GDP (in $ billions) and the percentage of their GDP accounted for by agriculture, by industry, and by services. Multiply GDP by the percentages to obtain the dollar amount of GDP coming from each of these sectors, which is interpreted as the *value-added* in each sector, that is, the dollar amount that is sold in each sector minus the cost of materials (not including the cost of labor or capital) used in production.

Answer:

2014	GDP (billion $)	Agriculture (%)	Industry (%)	Service (%)
France	2829.2	2	19	79
Thailand	404.8	20	37	53

d. Using your results from parts (b) and (c), divide the GDP from each sector by the labor force in each sector to obtain the *value-added per worker in each sector*. Arrange these numbers in the same way as the "Sales/Employee" and "Bushels/Worker" shown in Table 2-2. Then compute the absolute advantage of one country relative to the other in each sector, as shown on the right-hand side of Table 2-2. Interpret your results. Also compute the comparative advantage of agriculture/industry and agriculture/services (as shown at the bottom of Table 2-2), and the comparative advantage of industry/services. Based on your results, what should be the trade pattern of these two countries if they were trading only with each other?

Answer:

($1000)	France	Thailand	Absolute Advantage France/Thailand Ratio
Service	97.94	13.93	7.03
Industry	84.39	18.4	4.59
Agriculture	61.50	4.89	12.58
Comparative Advantage			
Agriculture/ Service	0.63	0.35	
Agriculture/ Industry	0.73	0.27	
Industry/Service	0.86	1.33	

Thailand has a comparative advantage in both Service and Industry. Suppose that a farmer spends 1,000 hours per year in agriculture production. Multiplying the marginal product of an hour of labor in agriculture by 1,000, to obtain the marginal production of labor per year and dividing by the marginal production of labor in Service gives us the opportunity cost of Service. In France, this ratio is 0.63, indicating that $0.63 must be foregone to obtain an extra dollar of sales in Agriculture. In Industry, the ratio is 0.73 in France. These ratios are much smaller in Thailand, only 0.35 for Service and 0.27 for Industry. As a result, Thailand has a lower opportunity cost of both Industry and Service. Therefore, if assuming the two countries are trading only with each other, France will export Agriculture while Thailand will export Service and Industry.

2. 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 Ricardo describes can produce 1,000 yards of cloth or 2,000 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?

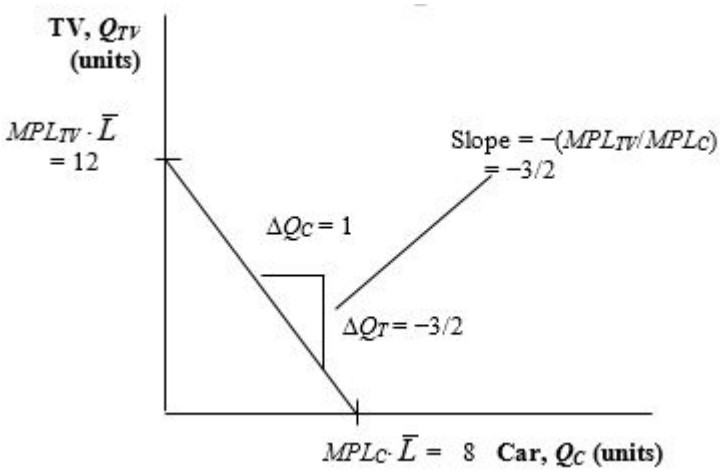
Answer: In England, 100 men produce 1,000 yards of cloth, so MPL_C = 1,000/100 = 10. 120 men produce 2,000 bottles of wine, so MPL_W = 2,000/120 =16.6. In Portugal, 90 men produce 1,000 yards of cloth, so MPL^*_C = 1,000/90 = 11.1. Eighty (80) men produce 2,000 bottles of wine, so MPL^*_w = 2,000/80 = 25. So Portugal has an absolute advantage in both cloth and wine, because it has higher marginal products of labor in both industries than does England.

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?

Answer: For England, $P_W/P_C = MPL_C/MPL_W$ = 10/16.6 = 0.6, which is the no-trade relative price of wine (equal to the opportunity cost of producing wine). So the opportunity cost of wine in terms of cloth is 0.6, meaning that to produce 1 bottle of wine in England, the country gives up 0.6 yards of cloth. For Portugal, P_W^*/P_C^*= MPL_C^*/MPL_W^* = 11.1/25 = 0.4, which is the no-trade relative price of wine (equal to the opportunity cost of producing wine). The no-trade relative price of wine is lower in Portugal, so Portugal has comparative advantage in wine, and England has comparative advantage in cloth. Portugal has comparative advantage in producing wine because it has lower opportunity cost (P_W^*/P_C^*= 0.4) than England in the production of wine (P_W/P_C= 0.6).

3. Suppose that each worker in Home can produce two cars or three TVs. Assume that Home has four workers.

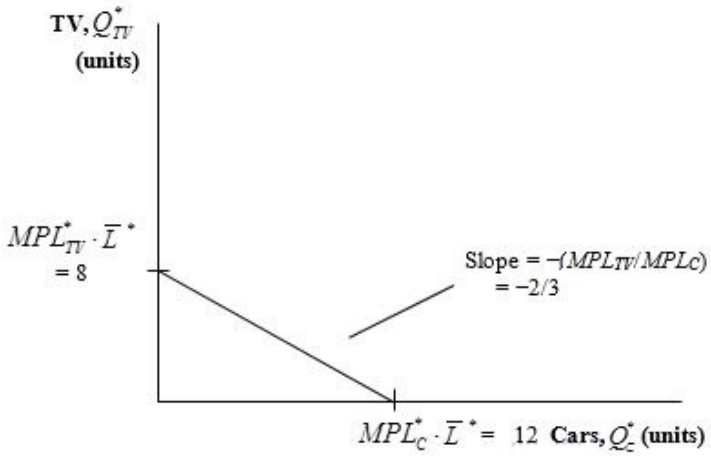
a. Graph the production possibilities frontier for Home.
Answer: See the following figure.



b. What is the no-trade relative price of cars in Home?
Answer: The no-trade relative price of cars at Home is $P_C/P_{TV} = 3/2 = MPL_{TV}/MP_C$. It is the slope of the PPF curve for Home.

4. Suppose that each worker in Foreign can produce three cars or two TVs. Assume that Foreign also has four workers.

a. Graph the production possibilities frontier for Foreign.
Answer: See following figure.



b. What is the no-trade relative price of cars in Foreign?

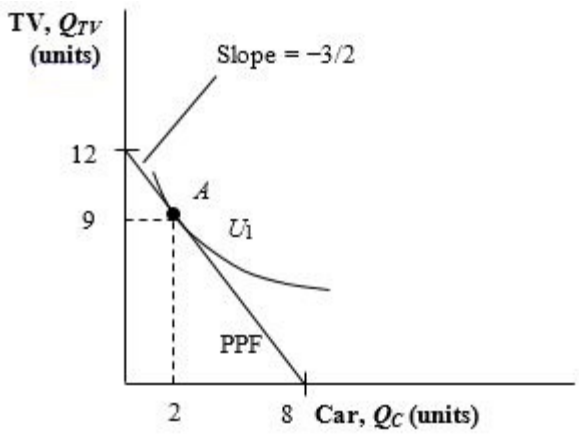
Answer: The no-trade relative price of cars in Foreign is $P^*_C/P^*_{TV} = 2/3 =$

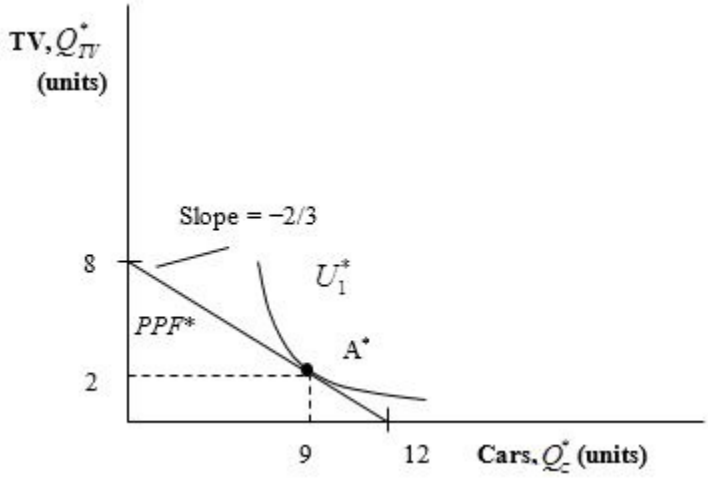
c. Using the information provided in Problem 3 regarding Home, in which good does Foreign have a comparative advantage, and why?

Answer: Foreign has a comparative advantage in producing televisions because it has a lower opportunity cost than Home in the production of televisions.

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

Answer: See following figures.

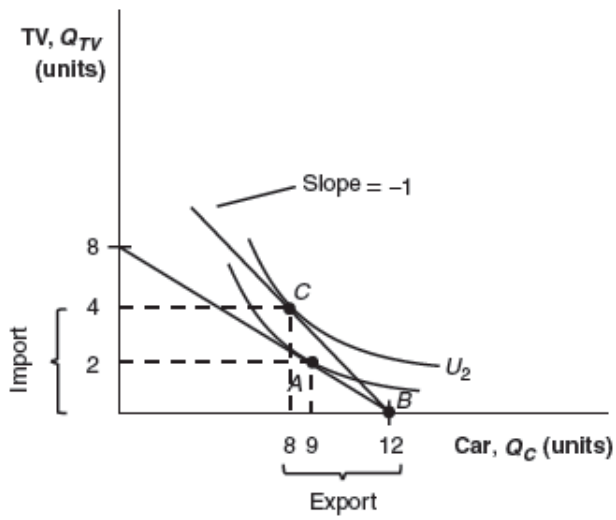




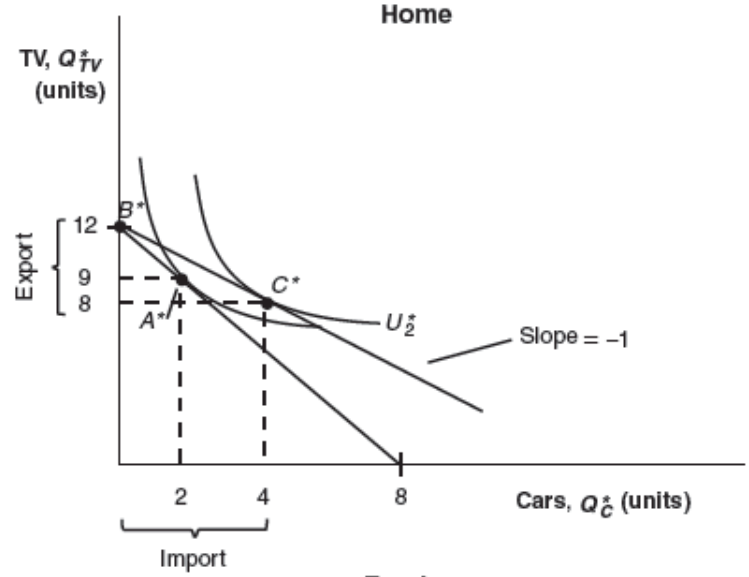
6. Now suppose the world relative price of cars is $P_C/P_{TV} = 1$.

a. In what good will each country specialize? Briefly explain why.
Answer: Home would specialize in TVs, export TVs, and import cars, whereas the Foreign country would specialize in cars, export cars, and import TVs. The reason is because Home has a comparative advantage in TVs and Foreign has a comparative advantage in cars.

b. Graph the new world price line for each country in the figures in Problem 5, and add a new indifference curve (U_2) for each country in the trade equilibrium.
Answer: See the following figures.



Home



Foreign

c. Label the exports and imports for each country. How does the amount of Home

exports compare with Foreign imports?
Answer: See graph in part (b). The amount of Home TV exports is equal to the amount of Foreign TV imports. In addition, Home imports of cars equal Foreign exports of cars. This is balanced trade, which is an essential feature of the Ricardian model.

d. Does each country gain from trade? Briefly explain why or why not.
Answer: Both Home and Foreign benefit from trade relative to their no-trade consumption because their utilities are both higher (consumption bundles located on higher indifference curves).

Work It Out

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

	Home	**Foreign**	**Absolute Advantage**
Number of bicycles produced per hour	4	6	?
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.
Answer: See previous table.

b. Which country has an absolute advantage in the production of bicycles? Which country has an absolute advantage in the production of snowboards?
Answer: Foreign has an absolute advantage in both production of bicycles and snowboards, because it is able to produce more in an hour than Home.

c. What is the opportunity cost of bicycles in terms of snowboards in Home? What is the opportunity cost of bicycles in terms of snowboards in Foreign?
Answer: The opportunity cost of one bicycle is 3/2 snowboards at Home ($P_B/P_S = MPL_S/MPL_B = 6/4 = 3/2$). The opportunity cost of one bicycle is 4/3 snowboards in the Foreign country ($P_B^*/P_S^* = MPL_S^*/MPL_B^* = 8/6 = 4/3$).

d. Which product will Home export, and which product does Foreign export? Briefly explain why.
Answer: The opportunity cost of one bicycle is 3/2 snowboards at Home ($P_B/P_S = MPL_S/MPL_B = 6/4 = 3/2$). The opportunity cost of one bicycle is 4/3 snowboards in the Foreign country ($P_B^*/P_S^* = MPL_S^*/MPL_B^* = 8/6 = 4/3$). Home has a smaller opportunity cost producing snowboards than the Foreign country. Home will export snowboards and Foreign will export bicycles.

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		Foreign	
$Wage_{TV} = 12$	$Wage_C = ?$	$Wage^*_{TV} = ?$	$Wage^*_C = 6$
$MPL_{TV} = 4$	$MPL_C = ?$	$MPL^*_{TV} = ?$	$MPL^*_C = 1$
$P_{TV} = ?$	$P_C = 4$	$P^*_{TV} = 8$	$P^*_C = ?$

a. What is the marginal product of labor for TVs and cars in Home? What is the no-trade relative price of TVs in Home?
Answer: $MPL_C = 3$, $MPL_{TV} = 4$, and $P_{TV}/P_C = MPL_C / MPL_{TV} = 3/4$

b. What is the marginal product of labor for TVs and cars in Foreign? What is the no-trade relative price of TVs in Foreign?
Answer: $MPL^*_C = 1$, $MPL^*_{TV} = 3/4$, and $P^*_{TV}/P^*_C = MPL^*_C/MPL^*_{TV} = 4/3$

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.

Answer: Home will export TVs and Foreign will export cars because Home has a comparative advantage in TVs whereas Foreign has a comparative advantage in car. Each country will specialize in the goods with lower opportunity cost.

d. In the trade equilibrium, what is the real wage in 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?
Answer: Workers at Home are paid in terms of TVs because Home exports TVs. Home is better off with trade because its real wage in terms of cars has increased.

$$\text{Home wages with trade} = \begin{cases} MPL_{TV} = 4 \text{ units of TV} \\ \text{or} \\ (P_{TV}/P_C)\cdot MPL_{TV} = (1)\cdot 4 = 4 \text{ units of car} \end{cases}$$

$$\text{Home wages w/o trade} = \begin{cases} MPL_{TV} = 4 \text{ units of TV} \\ \text{or} \\ (P_{TV}/P_C)\cdot MPL_{TV} = (3/4)\cdot 4 = 3 \text{ units of car} \end{cases}$$

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?
Answer: Foreign workers are paid in terms of cars because Foreign exports cars. Foreign gains in terms of cars with trade.

Foreign wages with trade= $\begin{cases} (P_C/P_{TV}) \cdot MPL_C^* = (1) \cdot 1 = 1 \ units \ of \ TV \\ or \\ MPL_C^* = 1 \ units \ of \ car \end{cases}$

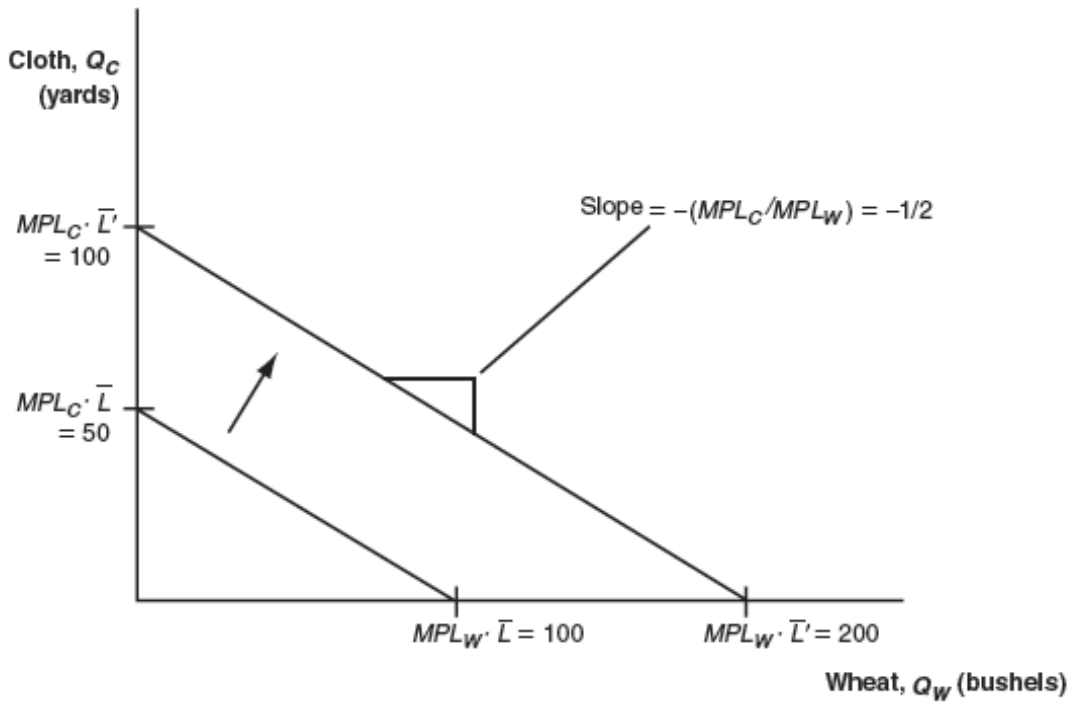
Foreign wages w/o trade= $\begin{cases} (P_C^*/P_{TV}^*) \cdot MPL_C^* = (3/4) \cdot 1 = 3/4 \ unit \ of \ TV \\ or \\ MPL_C^* = 1 \ units \ of \ car \end{cases}$

f. In the trade equilibrium, do Foreign's workers earn more or less than Home's workers, measured in terms of their ability to purchase goods? Explain why.
Answer: Foreign workers earn less than workers at Home in terms of cars because Home has an absolute advantage in the production of cars. Home workers also earn more than Foreign workers in terms of TVs

8. Why do some low-wage countries, such as China, pose a threat to manufacturers in industrial countries, such as the United States, whereas other low-wage countries, such as Haiti, do not?
Answer: To engage in international trade, a country must have a minimal threshold of productivity. Countries such as China have the productivity necessary to compete successfully, but Haiti does not. China can enter the world market because it beats other industrial countries with a lower price. Under perfect competition, price is determined by both wage rate and productivity; that is, *P = Wage/MPL*. So the lower price in China comes from both a low wage rate and high *MPL*. Haiti has a low wage rate, but also low *MPL*. So Haiti's price is not low enough to enter the world market.

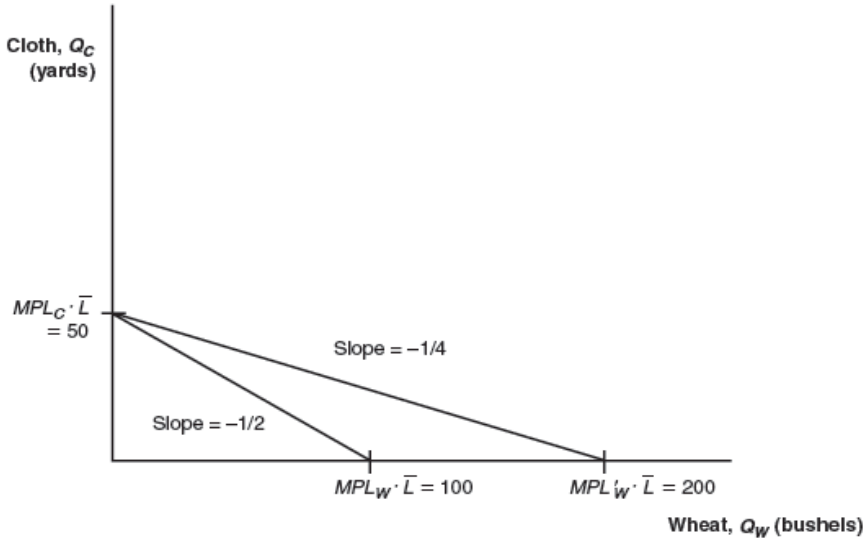
Answer Problems 9 to 11 using the chapter information for Home and Foreign.

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?



Answer: With the doubling of the number of workers in Home, it can now produce 200 = 4 · 50 bushels of wheat if it concentrates all resources in the production of wheat, or it could produce 100 = 2 · 50 yards of cloth by devoting all resources to the production of cloth. The PPF shifts out for both wheat and cloth. The no-trade relative price of wheat remains the same because both MPL_W and MPL_C are unchanged.

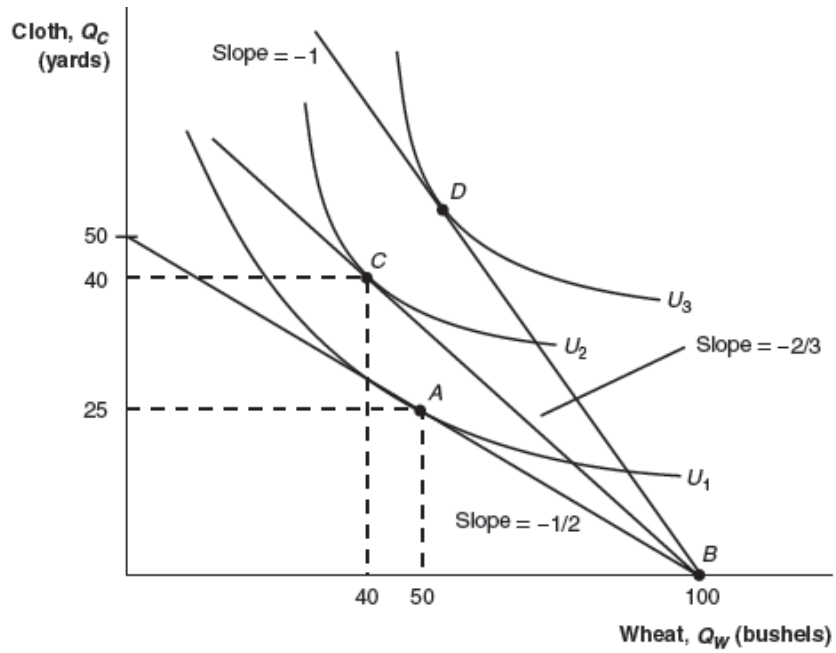
b. Suppose that there is technological progress in the wheat industry such that Home can produce more wheat with the same amount of labor. What happens to the Home PPF and what happens to the relative price of wheat? Describe what would happen if a similar change occurred in the cloth industry.



Answer: Because the technological progress is only in the wheat industry, Home's production of cloth remains the same if it devotes all of its resources to producing cloth. If instead Home produces only wheat, it is able to produce more wheat using the same amount of labor. Home's PPF shifts out in the direction of wheat production. Recall that the relative price of wheat is given by $P_W/P_C = MPL_C/MPL_W$. With the technological progress in wheat, the marginal product of labor in the wheat production increases. Thus, the relative price of wheat decreases. As shown in the graph, the relative price of wheat drops from 1/2 to 1/4.

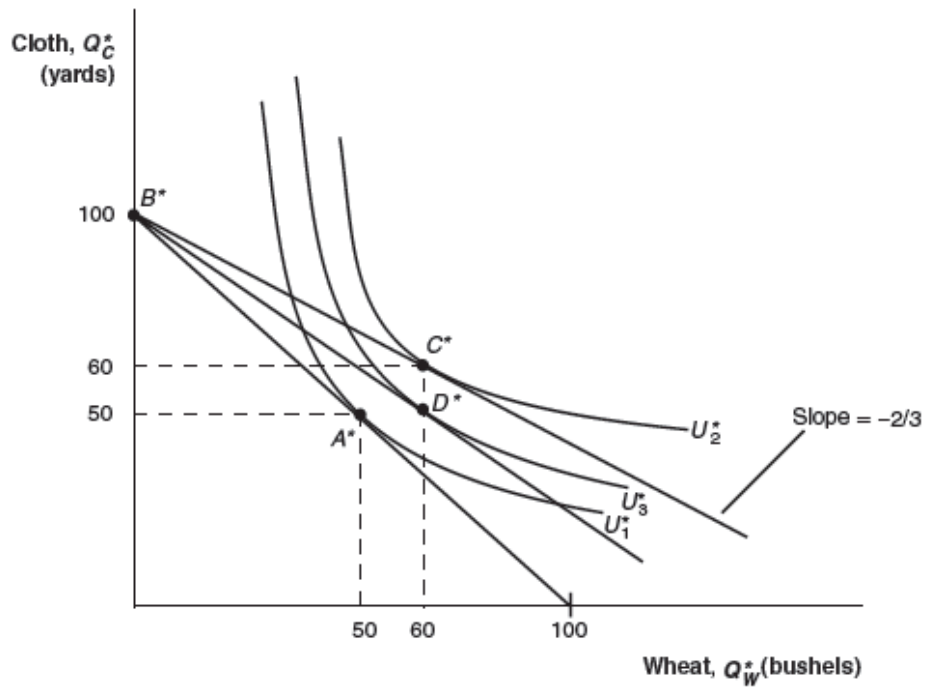
If instead the technological progress is in the cloth industry, we would have the opposite results. Home's PPF would shift out in the direction of cloth production and the relative price of wheat would increase.

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.



Answer: The increase in the relative price of wheat from its international equilibrium of 2/3 allows Home to consume at a higher utility, such as at point *D*.

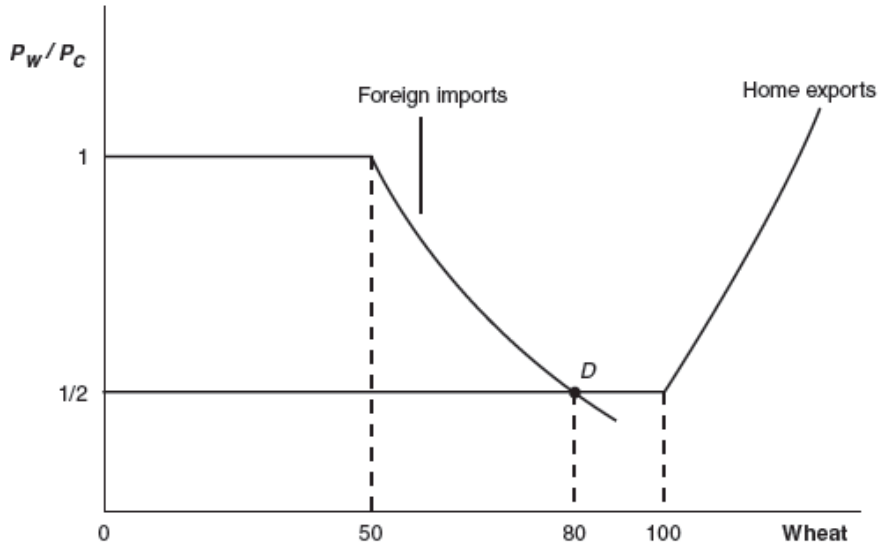
b. Using Figure 2-6, show that an increase in the relative price of wheat from its world relative price of $\frac{2}{3}$ will lower Foreign's utility. What is Foreign's utility when the world relative price reaches 1, and what happens in Foreign when the world relative price of wheat rises above that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



Answer: The increase in the relative price of wheat from its international equilibrium of $\frac{2}{3}$ lowers Foreign's utility to U^*_3 with consumption at D^*. When the international price reaches 1, it becomes the same as Foreign's no-trade relative price of wheat. Thus, Foreign consumes at point A^*, the no-trade equilibrium. If the international price rises above 1, then it would be greater than Foreign's no-trade relative price of wheat. In this case, Foreign would switch to exporting wheat instead of exporting cloth. The world price line now moves inside the PPF, which will lower the no trade relative price of wheat.

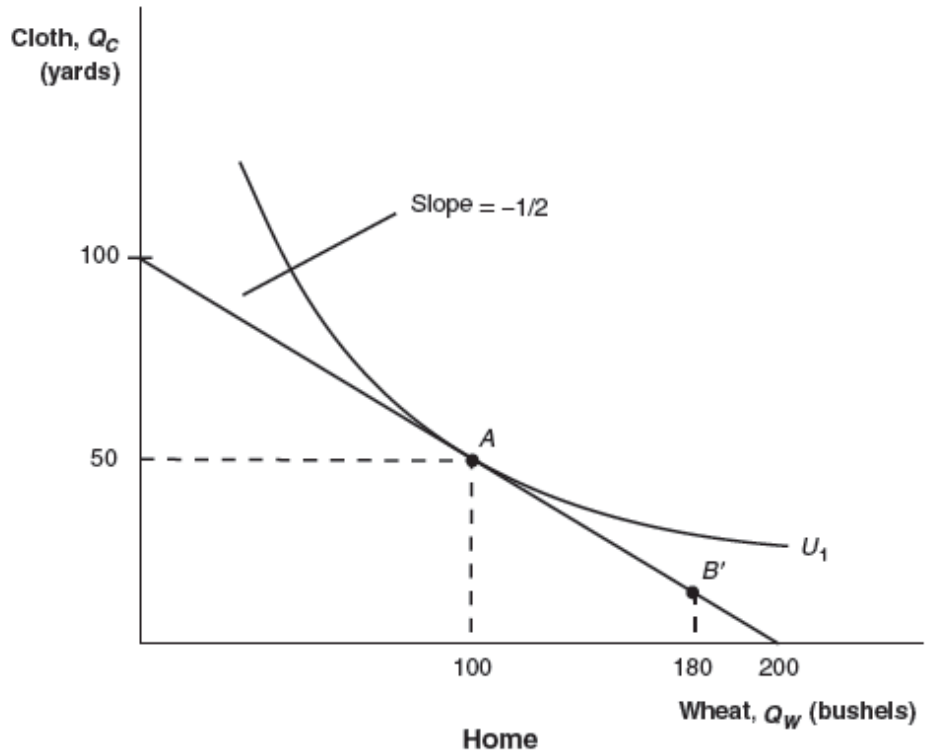
11. *(This is a harder question.)* Suppose that Home is much larger than Foreign. For example, suppose we double the number of workers in Home from 25 to 50. Then, suppose that Home is willing to export up to 100 bushels of wheat at its no-trade price of $P_W/P_C = \frac{1}{2}$, rather than 50 bushels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

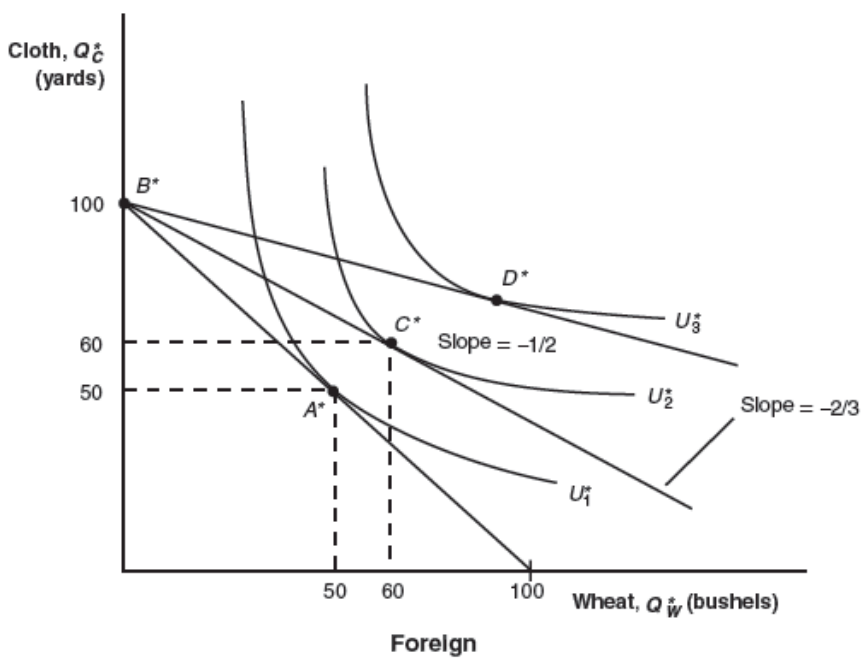
a. From this figure, what is the new world relative price of wheat (at point *D*)?
Answer: The intersection of the Foreign imports and Home exports gives the new international equilibrium relative price of wheat, which is $\frac{1}{2}$.



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.

Answer: The international price of $\frac{1}{2}$ is the same as Home's no-trade relative price of wheat. Home would consume at point *A* and produce at point *B′*. The difference between these two points gives Home exports of wheat of 80 units. (Notice that workers earn equal wages in the two industries, so production can occur anywhere along the PPF.)





Because the international price of 1/2 is lower than Foreign's no-trade relative price of wheat, Foreign is able to consume at point D^*, which gives higher gains from trade than at point C^*.

c. Are there gains from trade in both countries? Explain why or why not.
Answer: The Foreign country gains a lot from trade, but the home country neither gains nor loses: Its consumption point A is exactly the same as what it would be in the absence of trade. This shows that in the Ricardian model, a *small* country can gain the most from trade, whereas a *large* country may not gain (although it will not lose) because the world relative price might equal its own no-trade relative price. So the large country does not see a terms of trade (TOT) gain. This special result will not arise in other models that we study, but illustrates how being small can help a country on world markets!

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.
Answer: The Ricardian model predicts that Mexico would gain more than the United States when the two countries join the regional trade agreement because relative to the United States in terms of economic size, Mexico is a small country. For the United States, the world price of its exports is similar to the domestic price. Thus, there is not much TOT gain. But for Mexico, the world price is much higher than the domestic price of its exports, so Mexico sees a big TOT improvement.

2 Trade and Technology: The Ricardian Model

Notes to Instructor

Chapter Summary

The first chapters of this textbook address the question of why countries trade with one another. We will find that the reasons for trade include differences in technology, resources, cost of offshoring, and proximity to trading partners.

This chapter addresses the first item above, technology, as an explanation for trade. This reason was first proposed by David Ricardo, a nineteenth-century economist. Thus, the model is called the **Ricardian model.**

The Ricardian model is based on the level of technology in use within nations. As the use of technology within industries varies, some goods will have a comparative advantage over other goods. Having a comparative advantage in a good means that a country can produce some goods at a lower opportunity cost compared with their other goods. The Ricardian model will show that a nation will trade in the good in which it has the comparative advantage in spite of having an absolute advantage with other nations in producing all goods.

We will also learn that although comparative advantage will determine patterns of trade, absolute advantage will determine wages within countries. A nation will pay higher wages for the very reason that it has an absolute advantage in all goods: If it has better technology, its workers will be more productive and thus will be paid the value of the resulting higher marginal product.

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The three key lessons of the Ricardian model are as follows: (1) Comparative advantage determines the pattern of trade; (2) there are mutual gains from trade; and (3) wages are determined by absolute advantage.

As a sidenote, the snowboard example in the beginning of the chapter serves as an introduction to all the trade chapters (Chapters 2–7), allowing the instructor to skip Chapter 1 if desired. Keep in mind, though, that Chapter 1 provides a good overview of who trades with whom and by how much in the real world. It is also a good overview of the international trade topics that this book discusses. Chapter 1 provides an excellent background and springboard for students that may help to guide them toward an understanding of what international trade is really all about today. Too often, we assume it is only about goods traded across borders, but much more is traded in the factors of production, like capital. And migration has become a controversial issue as well, and this chapter makes clear why migration is fundamentally an international trade issue. This material may also help students to connect what they read in the news with the international trade topics covered in this text. Chapter 1 also offers a good historical perspective, suggesting that globalization and interconnectedness are not new to the international stage. In essence, the material in Chapter 1 will connect students to today's international trade issues and challenges, while providing an overview of what international trade entails and what will be covered in this text. However, if you are short on time, this is probably the one chapter that could be skipped.

Comments

Although most students may be familiar with the concept of comparative advantage from principles of microeconomics, it is a good idea to reintroduce this concept because many students find it challenging. This chapter also provides a more in-depth analysis of the Ricardian model by covering the

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determination of relative prices as well as the relationship between wages and absolute advantage. The latter is particularly interesting as it is not covered in most trade textbooks. A corresponding application provides convincing evidence regarding a country's level of technology and wages.

Lecture Notes

Introduction

Most manufactured products are traded between countries, including the snowboard. In 2014, the United States imported 350.6 thousand snowboards worth $28.2 million from 18 different countries. The top 12 countries selling snowboards to the United States are shown in Table 2-1, with China at the top of the list, followed by Austria, the United Arab Emirates, Taiwan, Canada, Switzerland, Germany, Slovenia, the Netherlands, France, Tunisia, and Slovak Republic. But, why does the United States purchase snowboards from these countries at all when it already has the resources and technology to produce the snowboards?

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TABLE 2-1

U.S. Imports of Snowboards, 2014

Rank	Country	Value of Imports ($ thousands)	Quantity of Snowboards (thousands)	Average Price ($/board)
1	China	12,991	210.5	62
2	Austria	9,981	75.3	133
3	United Arab Emirates	2,402	16.4	147
4	Taiwan	2,060	29.0	71
5	Canada	276	15.7	18
6	Switzerland	203	1.1	183
7	Germany	106	1.0	103
8	Slovenia	32	0.3	112
9	Netherlands	32	0.3	104
10	France	32	0.1	234
11	Tunisia	22	0.2	128
12	Slovak Republic	11	0.1	122
13–18	All other countries	23	0.6	41
	Total	28,172	350.6	80

Source: U.S. Department of Commerce and the U.S. International Trade Commission.

To answer this question and understand why countries trade goods with each other, we will examine the reasons for trade. These trade determinants include proximity (geographic distance between countries), resources (land, labor, and capital), offshoring, and differences in level of technology.

This chapter focuses mainly on the latter reason, technological differences across countries, and will use the "Ricardian model" named for nineteenth-century economist David Ricardo to explain trade between countries with differing levels of technology. The level of technology used by a country will determine the pattern of trade as well as the wages paid to labor.

1 Reasons for Trade

Proximity The proximity of Canada to the United States means lower transportation costs relative to

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trade between the United States and countries in Asia or Europe. This close distance between the two neighboring countries may explain why Canada is not only one of the top exporters of snowboards to the United States, but also one of its largest trading partner overall. Proximity may additionally be the reason why Europeans countries mainly trade with each other, whereas Japan or China is the largest trading partner for many Asian countries. Countries located in close proximity of one another often join free-trade areas to promote trade by eliminating barriers to trade such as tariffs and quotas.

Resources Resources are another reason that helps to explain why nations trade with one another. Consider Austria that sells some 30 times more in value to the United States than does Canada, in spite of Canada being significantly closer. And Mexico (included in the "All other countries" category) sells only some $6,000. How do we explain why Austria and Canada sell so much more than Mexico?

The reason may lie in the fact that, in contrast to Mexico, both Austria and Canada have cold snowy mountains ideal for snowboarding. Austria and Canada's geographic resource provides another reason for trade. Other resources are land, which also provides minerals; labor resources of various education and skills; and capital, such as machinery and infrastructure. Land, labor, and capital are often referred to as factors of production because these resources are used to produce goods and services. Favorable geographic conditions also help to explain the appearance of some of the other top 12 exporters of snowboards to the United States, namely, Switzerland, Germany, Slovenia, and France.

And it is important to note that a country can create a comparative advantage. Consider Germany's invention of ice wine, which is now also produced in the Niagara Falls region of Canada (see Side Bar:

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Can Comparative Advantage Be Created?). The United Arab Emirates is another such example, with a Ski Dubai indoor ski center having opened there. The country has since initiated an industry that produces high-quality snowboards.

The lower-priced snowboards from Canada ($18) and Mexico ($14) may be indicative of companies selling unfinished boards that require further processing. The process of trading unfinished goods and spreading production across several countries is called offshoring. This type of trade is covered in Chapter 7.

Absolute Advantage Although Germany also has a natural resource, the Alps on its southern border, the reason it is the seventh largest exporter of snowboards to the United States may be better explained by its advanced technology. As a world leader in the production of many manufactured goods, Germany has an absolute advantage in producing snowboards because it has the best technology to produce the good. Germany is known for producing many products, including machine tools, motor vehicles, and steel products that require high levels of technology.

However, this raises the question as to why the United States imports about 4 times more snowboards from China, a country with less-advanced technology relative to Germany. Indeed, it is also puzzling why the United States, with technology equal to that of Germany, would import snowboards from either country, rather than producing snowboards on its own.

S I D E B A R

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

By linking the production of "icewine," first developed in Germany in 1794, to the cold climate of its

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Niagara Falls region, Canada is able to create a new comparative advantage in producing this sweet dessert wine.

Comparative Advantage To determine trade patterns, we need to examine the relative rather than absolute differences in technology between countries. To gain a better understanding of the topic, we turn to the concept of comparative advantage, introduced by David Ricardo using a simple example consisting of two countries (Portugal and England) trading two goods (wine and cloth). Ricardo allowed Portugal to have the best technology or absolute advantage in the production of both goods. In contrast, although England is capable of producing both goods, it is relatively more difficult for England to produce wine. Given Ricardo's assumption that England is better at producing cloth than wine, England has a comparative advantage in the production of cloth and should export cloth to Portugal. In exchange for the cloth from England, Portugal should export wine because it has a comparative advantage in the production of that good.

The concept of comparative advantage may explain why the United States imports more snowboards from China than Germany, even though China has less-advanced technology in the production of snowboards relative to Germany or the United States. The remainder of the chapter provides more detail about this fundamental theory in international trade.

S I D E B A R

David Ricardo and Mercantilism

David Ricardo introduced the concept of comparative advantage as the basis for trade in response to the mercantilist school of thought that a country should actively export while preventing imports with high

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tariffs on foreign goods. Assuming that countries have balanced trade, Ricardo showed that these countries could benefit by engaging in free trade. Ricardo's ideology of trade without barriers is the foundation of many international institutions, such as the United Nations, World Bank, and World Trade Organization (WTO).

2 Ricardian Model This section provides a detailed example of the Ricardian model with the home country trading wheat and cloth. We will find that absolute advantage is not a good reason for trade and that a better understanding of trade comes from a good understanding of comparative advantage within a nation. The comparative advantage model will show that the home country (Home) should export wheat and import cloth in spite of being able to produce both wheat and cloth cheaper than its trading partners.

The Home Country To gain a better understanding of the main concepts of the Ricardian model, we simplify the example by assuming that labor is the only factor of production for both goods. We use the information that one worker at Home can produce 4 bushels of wheat or 2 yards of cloth per hour. The marginal product of labor (MPL) of each good per hour at Home is then given by $MPL_W = 4 \cdot MPL_C = 2$.

Home Production Possibilities Frontier Suppose that there are $\bar{L} = 25$ workers in the home country. We will begin by plotting Home's **production possibilities frontier (PPF).** To graph the PPF, we calculate the maximum bushels of wheat Home could produce in an hour if all workers were employed in producing wheat. They could produce $Q_W = MPL_W \cdot \bar{L} = 4 \cdot 25 = 100$ bushels of wheat per hour. If instead all workers were employed in cloth, then they could produce $Q_C = MPL_C \cdot \bar{L} = 2 \cdot 25 = 50$ yards

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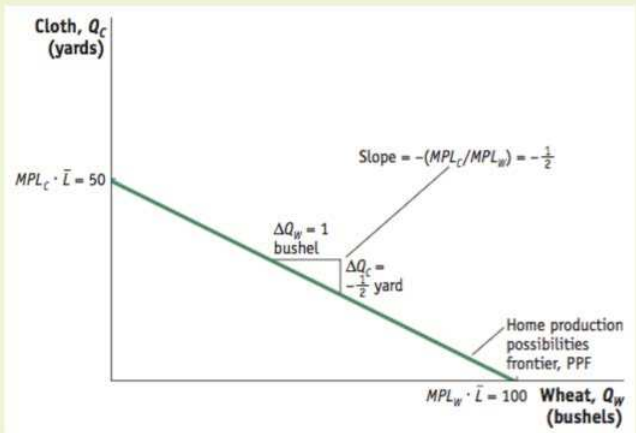
of cloth per hour. Connecting the two production points gives us the straight-line PPF unique to the Ricardian model, as shown in Figure 2-1. The PPF is a straight line because the marginal products of labors are constant, a result of the earlier assumption that production does not include land and capital. This means that there are no diminishing returns in the Ricardian model.

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 (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.

The slope of the PPF, equal to the ratio of the marginal products in the two goods, gives the opportunity cost of one good (on horizontal axis) in terms of the other (on vertical axis).

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

The slope of the PPF gives the opportunity cost of 1 bushel of wheat in terms of cloth. The slope of $-\frac{1}{2}$ means that Home gives up $\frac{1}{2}$ yard of cloth to increase the output of wheat by 1 bushel. To see this, notice that home country must give up one quarter of a worker's time to produce cloth to obtain 1 bushel of wheat. By shifting the 15 minutes from cloth to wheat, Home reduces cloth output by $\frac{1}{2}$ yard.

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Thus, $\frac{1}{2}$ yard of cloth is the opportunity cost of obtaining one more bushel of wheat and this is exactly the slope of the PPF.

You might point out to students that to calculate the opportunity cost *of* a good (in the denominator) in terms of the other good (in the numerator), the units will always be in the units of whatever is in the numerator. This always causes confusion for students.

Home Indifference Curve To determine the level of wheat and cloth production, we examine Home's demand for the two goods, as represented by the country **indifference curves**. Similar to indifference curves representing individual preferences, an indifference curve for a country reflects higher levels of **utility** the further away it is from the origin. In addition, Home is indifferent between any two combinations of wheat and cloth on the same indifference curve. For example, in Figure 2-2, the consumer is indifferent between points *A* and *B*. But, at point *C,* a higher indifference curve indicates that a higher level of utility is possible. In Figure 2-2, we are examining the entire nation and considering the preferences of the entire country. Notice that utility at U_0 represents a lower level of utility for all consumers in the country.

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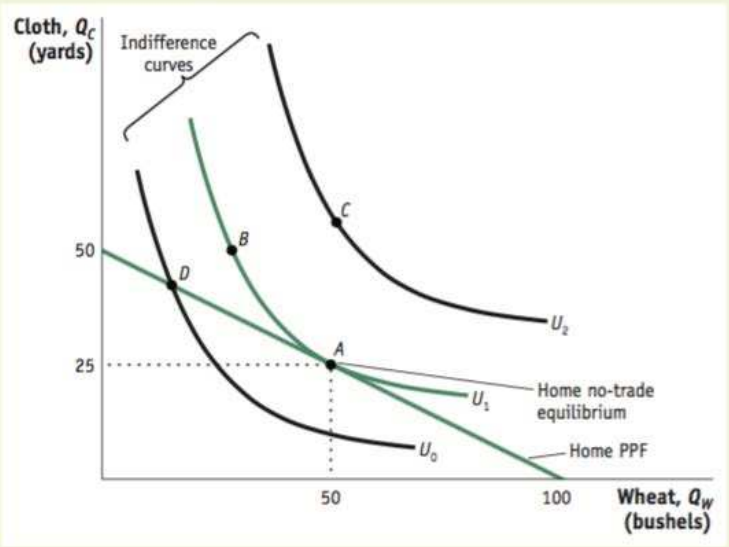
FIGURE 2-2



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 Equilibrium Without international trade, Home will produce at the point where the indifference curve is just tangent to the PPF, which acts like the country's budget constraint. Figure 2-2 shows that Home achieves the most satisfaction at the "no-trade" or the "pre-trade" equilibrium denoted by point *A*, at which U_1 represents the highest indifference curve Home can obtain by having its own firms produce and sell the two goods under perfect competition.

The highest level of utility that can be achieved in Figure 2-2 is at point *A,* where Home produces 25 yards of cloth and 50 bushels of wheat. This is the Autarky or no international trade position. This point assumes a competitive market, with many firms as price takers. This price for wheat and cloth is therefore given, and point *A* represents the highest level of well-being possible and is an example of Adam Smith's invisible hand at work.

Opportunity Cost and Prices Under perfect competition, at the no-trade equilibrium, the opportunity

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cost and relative price of wheat (on horizontal axis) are equal. This result follows from assuming that labor is perfectly mobile between the two industries and that firms will hire labor up to the point where wage in an industry equals the price of the good times the marginal product of labor in the sector producing the good.

We will now show that this equality between the opportunity costs and the relative price of wheat holds at point *A*.

Wages With labor freely able to move between the industries, wages across the industries must be equal, which gives the equality of the price ratio with the ratio of the marginal products in the two goods. Setting wage equal in the two sectors

$$P_W \cdot MPL_W = \text{wage} = P_C \cdot MPL_C$$

and rearranging gives

$$P_W / P_C = MPL_C / MPL_W$$

The right side is the slope of the PPF, which also is the opportunity cost of wheat in terms of cloth, whereas the left side is the relative price of wheat. Substituting the marginal product of labor in wheat and cloth, we find that the relative price of wheat in the home country without international trade is equal to $\frac{1}{2}$ ($P_W/P_C = MPL_W/MPL_C = \frac{1}{2}$).

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The price ratio (P_W/P_C) denotes the relative price of the good in the numerator and is measured in terms of how much of the good in the denominator must be given up. Thus, P_W/P_C is the relative price of wheat, which is on the horizontal axis. Note that the relative price of wheat represents the slope of the PPF.

The Foreign Country We have seen the equilibrium in both countries in the absence of trade. Now let's see what happens when trade begins. The lesson we will learn is that each country will export that good in which it has a comparative advantage over its trading partner, even though it may have an absolute advantage in both goods. This means that patterns of trade are determined, in the Ricardian model, by the opportunity costs of production.

In our model, the foreign country is assumed to have an inferior technology, or an absolute disadvantage in producing both wheat and cloth, as compared with Home. In particular, one worker can produce 1 bushel of wheat or 1 yard of cloth. Thus, the marginal product of labor in wheat and cloth in Foreign are $MPL_W^* = 1$ and $MPL_C^* = 1$, respectively.

With $\bar{L}^* = 100$, Foreign is able to produce a maximum of $MPL_W^* \cdot \bar{L} = 100$ bushels of wheat per hour if all workers were producing wheat. If instead all workers were employed in cloth production, Foreign would be able to produce a maximum of $MPL_C^* \cdot \bar{L} = 100$ yards of cloth per hour.

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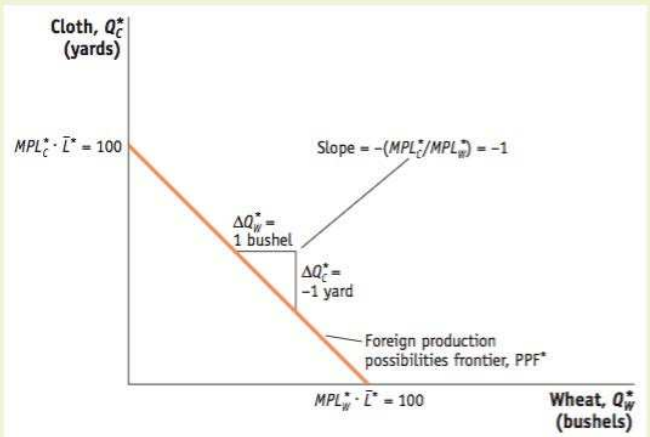
Foreign Production Possibilities Frontier The Foreign PPF, given in Figure 2-3, is the straight line between the two Foreign production points. The slope of the Foreign PPF, measured by the ratio of the marginal products in the two goods, is −1. We will now turn to the concept of comparative advantage to understand why the United States, with its superior technology in the production of both wheat and cloth, would import most of its clothing from countries in Asia and Latin America.

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.

Comparative Advantage The opportunity cost of 1 bushel of wheat in terms of yards of cloth in the *foreign* country is equal to 1. But, the opportunity cost of 1 bushel of wheat in terms of yards of cloth in the home country ($\frac{MPL_W}{MPL_C} = \frac{1}{2}$) is lower than that in the foreign country ($\frac{MPL_W^*}{MPL_C^*} = 1$) . This means that Home gives up less cloth to produce 1 bushel of wheat than Foreign. Because Home has a lower opportunity cost of producing wheat than Foreign, Home has a comparative advantage in producing wheat, whereas Foreign has a comparative advantage in producing cloth ($\frac{MPL_C}{MPL_W} = 2 > \frac{MPL_C^*}{MPL_W^*} = 1$), because its opportunity cost of producing cloth is lower than Home's opportunity cost. A country has a

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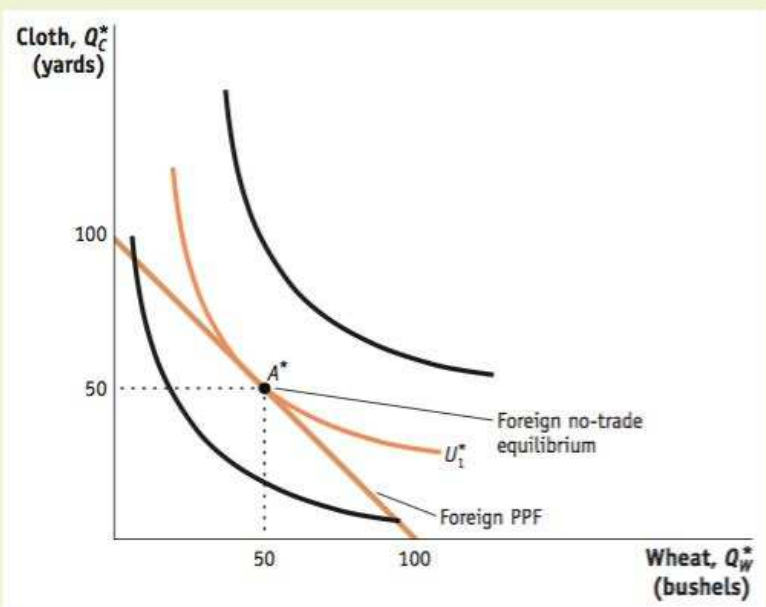
comparative advantage in a good when it is able to produce the good at a lower opportunity cost than its trading partner. Importantly, we get this result despite the assumption that Home has an absolute advantage in the production of both goods.

Applying the same methodology for Home, we include Foreign's preferences for wheat and cloth with indifference curves to obtain the no-trade equilibrium. Figure 2-4 shows that under competitive markets, Foreign will produce at point A^*, at which it achieves the highest level of utility. The slope of the foreign PPF gives us the relative price as well as the opportunity cost of wheat without trade ($MPL_W^* / MPL_C^* = P_W^* / P_C^* = 1$). The comparative advantage that the home country has in the production of wheat is also reflected by the lower relative price of wheat at Home ($P_W/P_C = \frac{1}{2}$), compared with Foreign.

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.

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APPLICATION

Comparative Advantage in Apparel, Textiles, and Wheat

Table 2-2 shows that a worker in the United States generates 2.6 times more apparel sales and 12 times more textiles sales per year than a worker in China. With its absolute advantage in the production of both industries, why does the United States import apparel and textiles from China and other Asian countries? The answer has to do with the fact that a typical wheat farmer in the United States is 33 times more productive than a farmer in China. With its absolute and comparative advantage in the production of grain, the United States exports grain to China in exchange for apparel and textiles, as predicted by the Ricardian model.

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 worker in producing wheat. The United States has an absolute advantage in all 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 by the numbers in the bottom rows of the table).

	United States	China	Absolute Advantage
	Sales/Employee	*Sales/Employee*	*U.S./China Ratio*
Apparel	$70,000	$27,000	2.6
Textiles	$232,000	$20,000	12
	Bushels/Worker	*Bushels/Worker*	*U.S./China Ratio*
Wheat	10,000	300	33
	Comparative Advantage		
	Bushels/$	*Bushels/$*	
Wheat/apparel ratio	0.14	0.01	
Wheat/textile ratio	0.04	0.01	

Note: Data are for 2013 or 2014.

Source: U.S. apparel and textile data from U.S. Bureau of Labor Statistics, 2014. U.S. wheat data from USDA Wheat Yearbook 2014. All China data from China Statistical Yearbook 2013.

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3 Determining the Pattern of International Trade

International Trade Equilibrium We now examine why the two countries participate in international trade. Because the relative price of wheat in the home country ($P_W/P_C = \frac{1}{2}$) is lower than the relative price of wheat in the foreign country ($P_W^* / P_C^* = 1$), producers of wheat at Home would want to export wheat to Foreign. Conversely, producers of cloth in the foreign country would want to export cloth since the relative price of cloth is higher in the home country ($P_C/P_W = 2$) than the foreign country ($P_C^* / P_W^* = 1$). Therefore, differences in no-trade prices provide an incentive for the two countries to trade.

As predicted by the Ricardian model, both countries export the good in which they have a comparative advantage. This is the fundamental law that determines trade patterns in the Ricardian model.

International trade equilibrium between the two countries occurs only when the relative price of wheat (or cloth) is the same across the countries. This occurs because as Home exports wheat, the supply of wheat in the home country falls, bidding up the price, while the supply of wheat in the foreign country increases, bidding down the price, leading to a higher relative price at Home and a lower relative price at Foreign. Similarly, the foreign country's export of cloth drives up the relative price of cloth in Foreign as supply decreases and leads to a fall in the relative price at Home. In the next section, we will determine the relative price of wheat at the trade equilibrium and examine how the change in the relative price of wheat, due to trade, affects production and consumption in each of the countries.

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Change in Production and Consumption We must address two questions to fully understand the international trade position:

1. What will be the relative price of wheat (cloth) in the trade equilibrium?
2. How does trade impact production and consumption in both Home and Foreign?

We will address the second question first and assume a relative price has been established. To determine how trade impacts each country's production and consumption patterns, we begin by supposing that the international relative price of wheat is equal to $\frac{2}{3}$, which is in-between Home's ($\frac{1}{2}$) and Foreign's (1) no-trade relative price. Given the higher international relative price of wheat ($\frac{2}{3} > \frac{1}{2}$), producers in the home country would want to export wheat abroad and all workers would want to work in the wheat industry.

To see that workers at Home would receive a higher wage working in the wheat industry than the cloth industry, we compute the ratio of wages in the two industries using the international relative price of wheat ($P_W/P_C = \frac{2}{3}$), and the marginal product of labor for cloth = MPL_C (2) and wheat = MPL_W (4):

$$\frac{\text{Wage}_w}{\text{Wage}_c} = \frac{P_w \cdot MPL_w}{P_C \cdot MPL_c} = (\frac{2}{3})(\frac{4}{2}) = \frac{8}{6} > 1, \text{which implies } P_w \cdot MPL_w > P_C \cdot MPL_c$$

Because of the higher wages in the wheat industry, no cloth is produced and the home country fully specializes in the production of wheat, as occurs at point *B* in Figure 2-5. This fully specialized position

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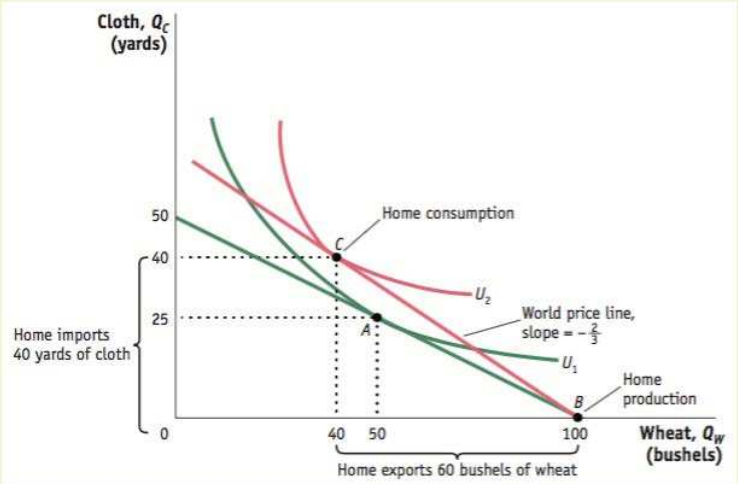
is due to the straight line for the PPF.

FIGURE 2-5



Home Equilibrium with Trade With a world relative price of wheat of 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 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 pre-trade levels.

International Trade Starting from Home's production point (point *B* in Figure 2-5), we know that with the international relative price of wheat at $\frac{2}{3}$, Home can export 1 bushel of wheat in exchange for $\frac{2}{3}$ yard of cloth from Foreign. Tracing out Home's international trade gives the international trade line shown as *BC* in Figure 2-5. The international trade line implies a "new" budget constraint for the home country that has a steeper slope ($-\frac{2}{3}$) than Home's PPF. This line, *BC,* is the world price line and is equal to the negative of the world relative price. This world price line represents the consumption possibilities that the nation is able to reach by specializing in only one good and then engaging in trade. This, in essence, allows the country to experience a higher budget constraint under international trade.

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Home's budget constraint is above its pre-trade PPF budget constraint and is thus able to choose a consumption point (point *C*) that is on a higher indifference curve (U_2). Therefore, Home gains from trade by obtaining a higher utility with international trade than under no-trade.

Pattern of Trade and Gains from Trade With the international relative price of wheat at $\frac{2}{3}$, Home produces 100 bushels of wheat (point *B*) but consumes only 40 bushels (point *C*). The extra 60 bushels are exported to the foreign country in exchange for 40 yards of cloth imported from Foreign. The value of the wheat in terms of cloth is determined by multiplying the international relative price of wheat by the amount of wheat export, $(\frac{2}{3}) \cdot 60 = 40$ yards of cloth. Because the value of exported wheat is equal to the value of imported cloth, trade in the home country is balanced.

The results for the foreign country produce trade patterns that are opposite those of the home country because the international relative price of wheat is less than the foreign no-trade relative price of wheat. These results are shown below in Figure 2-6. Workers in the foreign country will flock to the cloth industry as producers in this industry take advantage of the higher international relative price of cloth (reciprocal of the international relative price of wheat) to export cloth. Foreign becomes fully specialized in the production of cloth, denoted by point B^* in Figure 2-6. Tracing out Foreign's international trade at the exchange of $\frac{2}{3}$ yards of cloth for 1 bushel of wheat gives the international trade line, B^*C^*, which equals the negative of the slope of the international relative price of wheat ($\frac{2}{3}$) and is flatter than Foreign's PPF. The foreign country also gains from trade by acquiring a higher utility given by the tangency of indifference curve U_C^* with the international relative price of wheat at point C^*.

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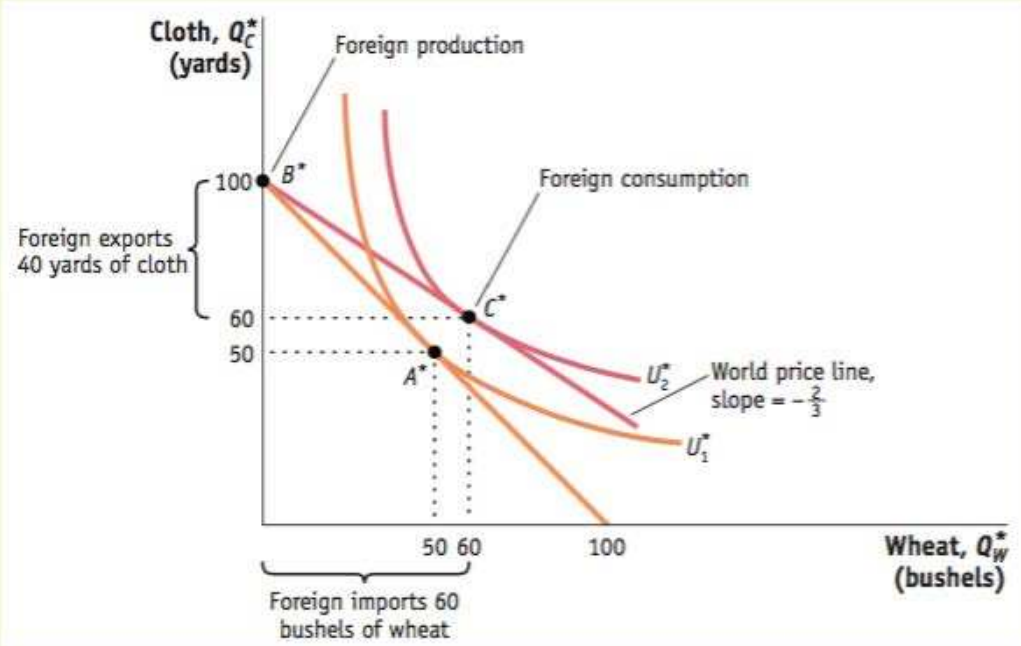
FIGURE 2-6



Foreign Equilibrium with Trade With a world relative price of wheat of 2/3, Foreign production will occur at point B^*. Through international trade, Foreign is able to export 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 pre-trade wheat and cloth consumption (point A^*), Foreign consumes 10 more bushels of wheat and 10 more yards of cloth.

Similar to the home country, trade in the foreign country is also balanced. By specializing in the production of cloth, Foreign produces 100 yards, 60 of which it keeps for consumption and the other 40 it exports to Home in exchange for 60 bushels of wheat. Note that the amount of cloth Foreign exports is exactly equal to the 40 yards that Home imports. Likewise, Foreign imports 60 bushels of wheat, which is the same amount that Home exports.

With international trade, the home country exports wheat, in which it has a comparative advantage, and the foreign country exports cloth because it has a comparative advantage in cloth. Both countries enjoy mutual gains from trade by consuming at a higher level of utility relative to their no-trade levels. These

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two findings are consistent with the Ricardian model, where the pattern of trade is determined by comparative advantage and both countries gain from trade.

A very important third lesson can be inferred from the Ricardian model. We have just learned that prices for the goods converge to a single equilibrium price. Is this also true for wages? Do wages converge to a single value across trading partners? The Ricardian model does not predict this. Even though trading patterns are determined by comparative advantage, wage determination within the countries is determined by absolute advantage within each nation. We will address this important corollary next.

Solving for Wages Across Countries In this section, we examine the relationship between absolute advantage and how wages are determined across countries. At Home, workers are paid in terms of wheat because the home country produces and exports this good. The workers could either consume their "real" wage, measured in terms of wheat, or exchange for cloth with Foreign at the international relative price of $P_W/P_C = \frac{2}{3}$. Wages at Home are summarized by the following:

Home wages = $MPL_W = 4$ bushels of wheat

or

$(P_W/P_C) \cdot MPL_W = \frac{8}{3}$ yards of cloth

In the foreign country, workers are paid in terms of cloth as Foreign produces and exports cloth. The real wage of workers in Foreign is $MPL_C^* = 1$ yards of cloth, which they can either consume or trade for wheat in the international market. Cloth workers sell their product on the world market for $\frac{3}{2}$ bushels.

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This means that their real wage in terms of wheat is $\frac{3}{2}$ bushels. Foreign wages are summarized by the following:

$$(P^*_C/P^*_W) \cdot MPL^*_C = \frac{3}{2} \text{ bushels of wheat}$$

Foreign wages = *or*

$$MPL^*_C = 1 \text{ yards of cloth}$$

Wages across the countries depend on the marginal products of labor and the international trade relative price of the goods.

Absolute Advantage Note that the because Home has an absolute advantage in both goods, Foreign workers earn less than Home workers, as made evident by how much less they can purchase of either good—1 yard of cloth or $\frac{3}{2}$ bushels of wheat compared to Home's ability to purchase $\frac{8}{3}$ yards of cloth or 4 bushels of wheat. Home workers can afford to purchase more of wheat and cloth than Foreign workers because the home country has an absolute advantage in the production of both goods. This is implied by the Ricardian model. Since trade is determined by comparative advantage, if a country has poor technology, the only way that it can compete and sell at a price that Home is willing to pay is if Foreign's wages are lower.

This does not imply that for developing countries, trade will only occur if wages are low. In fact, as trade progresses and the country begins to develop, so, too, will its technology. As it becomes more technologically advanced and thus more productive, its wages will begin to increase as well. The

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Ricardian model predicts this very scenario.

Data support this theory as both China and India have experienced it. After 36 years of international trade in China, the nation's per capita income by 2014 had increased nearly 8 times from $1,600 to $12,400, implying that the real income of Chinese consumers doubled every 12 years. Similarly, in India, its per capita income increased 4 times in 36 years of international trade from $1,300 to $5,600, implying that real income doubled every 18 years.

APPLICATION

Labor Productivity and Wages

Using value-added per hour as the measure for labor productivity, we see from Figure 2-7 that there is a relationship between labor productivity and wages. Of the seven countries presented, the United States has the highest level of productivity and enjoys the highest wage, whereas Taiwan has the lowest level of productivity and thus receives the lowest wage. Figure 2-8 shows the labor productivity and wages over time for each of the seven countries. The graphs indicate a close connection between labor productivity and wages, with both rising over time.

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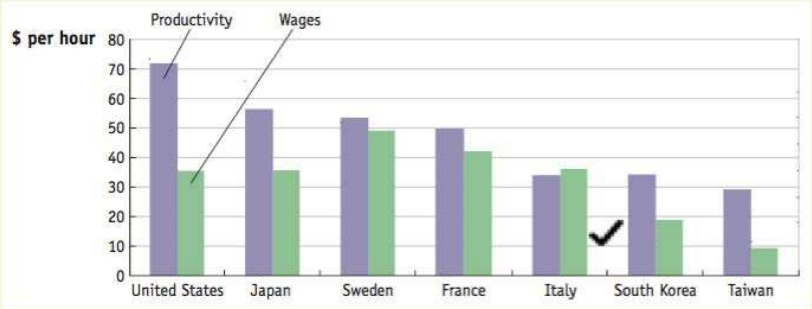
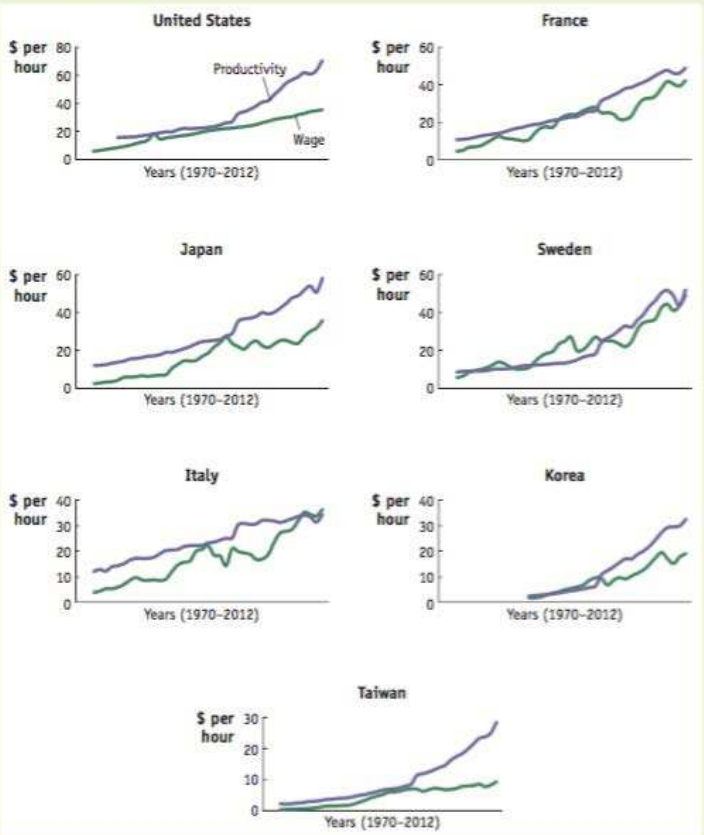
FIGURE 2-7



Labor Productivity and Wages, 2011 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 in terms of labor productivity—from highest to lowest—is the same as the ranking in terms of wages: countries with higher labor productivity generally pay higher wages, just as the Ricardian model predicts.

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

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.

4 Solving for International Prices

Instead of assuming that the international relative price of wheat is between the two countries' no-trade **relative prices** as we did in the previous section, we now solve for it using supply and demand curves, in which the world supply curve is derived from the Home **export supply curve,** whereas the world demand curve is derived from the Foreign **import demand curve**. The intersection of the export supply curve and the import demand curve determines the international prices.

Home Export Supply Curve We use panel (a) of Figure 2-9, which is a replica of Figure 2-5, to construct the Home export supply curve, in which the vertical axis measures the relative price of wheat and the horizontal axis measures the exports of wheat. The export supply curve of wheat is equal to zero when the international relative price of wheat is below the home country's no-trade price ratio ($\frac{1}{2}$). When the international relative price of wheat is equal to the home country's no-trade price ratio, the export supply curve is flat, starting from zero to the home country's no-trade consumption point [points A' and B' in panel (b) of Figure 2-9 corresponding with points A and B in panel (a)]. At the international relative price of wheat ($\frac{2}{3}$), Home could be entirely self-sufficient by producing and consuming at point A or it could completely specialize in the production of wheat by producing 100 bushels at point B. Because Home consumes only 40 bushels of wheat, the rest are exported to Foreign in exchange for 40 yards of cloth. In addition, with wages equal across the two industries, workers can freely move from one industry to another so that Home would produce on any point on the PPF between A and B. If the international relative price of wheat is $\frac{2}{3}$, we know from the earlier analysis that Home exports 60 bushels of wheat, corresponding with point C' in panel (b). The export supply curve rises as the relative

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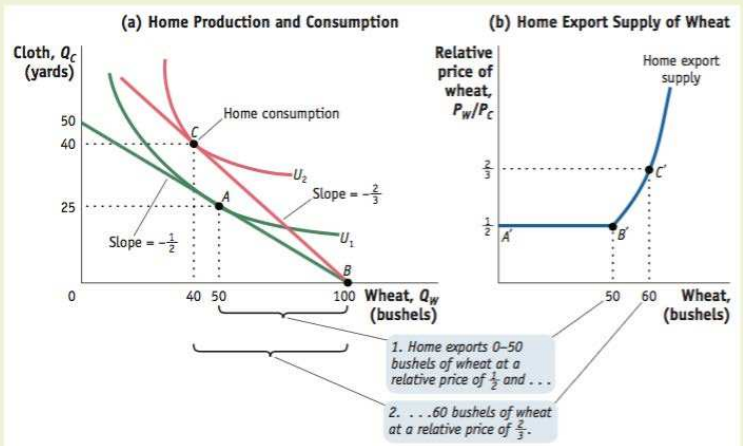
prices of wheat increase.

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 Home's export supply of wheat. When the relative price of wheat is 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 1/2, Home exports more than 50 bushels, along the segment *B′C′*. For example, at the relative price of 2/3, Home exports 60 bushels of wheat.

Foreign Import Demand Curve Using the same reasoning, the import demand curve for wheat is equal to zero when the international relative price of wheat is above the foreign no-trade relative price of wheat. If the international relative price of wheat is equal to 1, Foreign could either consume all of the wheat and cloth it produces on its own [points A^* and $A^{*\prime}$ in panels (a) and (b) of Figure 2-10, respectively] or specialize in the production of cloth by producing 100 yards and exporting 50 yards to the home country [points B^* and $B^{*\prime}$ in panel (a) and points $A^{*\prime}$ and $B^{*\prime}$ in panel (b)]. Because wages are equal across the two industries, Foreign could produce anywhere on its PPF between points A^* and B^*, which gives the flat segment of the import demand curve when the international relative price of wheat equals the foreign country's no-trade relative price. As the relative price of wheat decreases, for example, from 1 to $\frac{2}{3}$, the foreign country will specialize in cloth and import more wheat, leading to the

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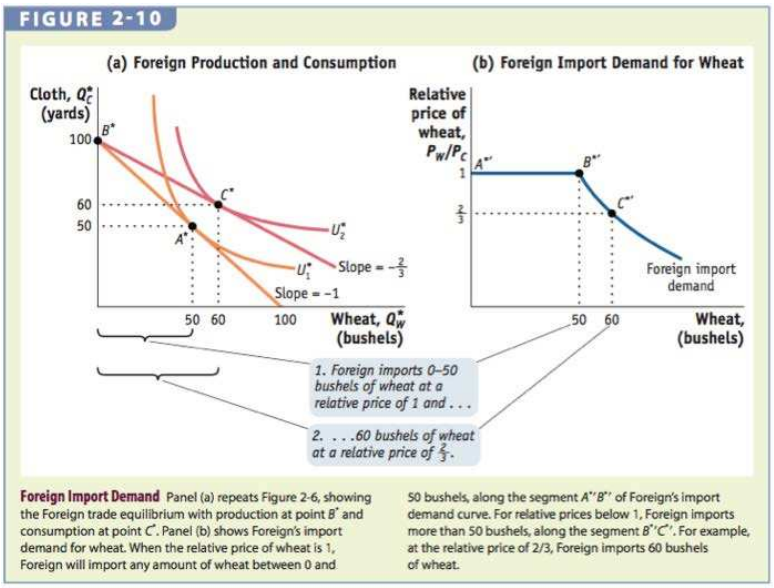
downward-sloping import demand curve for wheat. The flat portion of the import demand is unique to the Ricardian model because of the straight-line production possibilities frontier.



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's 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 Foreign's 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 2/3, Foreign imports 60 bushels of wheat.

International Trade Equilibrium Combining the Home export supply curve and the Foreign import demand curve gives the world market for wheat, as shown in Figure 2-11. The intersection of the world supply and demand curves, denoted by point C', gives the international trade equilibrium, in which the Home export of wheat is equal to Foreign import of wheat at the equilibrium relative price of wheat.

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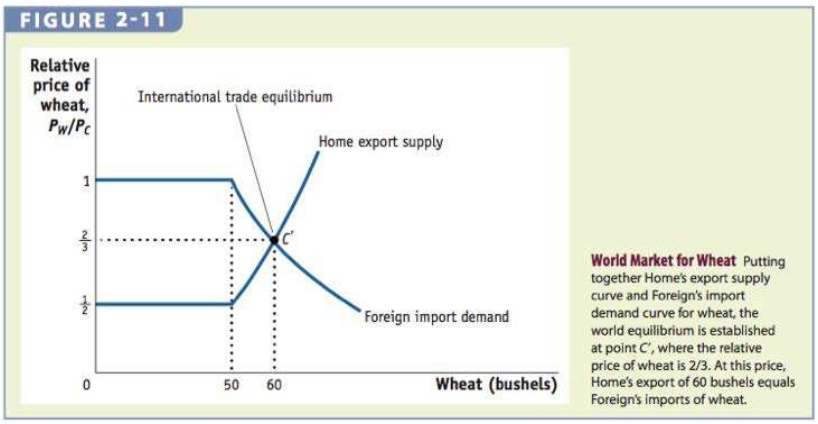

The Terms of Trade This is defined as the price of a country's exports divided by the price of its imports. The home country's terms of trade, defined by P_W/P_C, improve as the price of wheat increases or as the price of cloth falls. This means that the home country is able to purchase more cloth while exporting the same amount of wheat. For the foreign country, its terms of trade (P_C/P_W) rise following a higher price of cloth (its export) or a lower price of wheat (its imports). The terms of trade can make a country better off (earning more for exports or less for imports) or worse off (earning less for exports or paying more for imports).

APPLICATION

The Terms of Trade for Primary Commodities

In 1950, economists Raúl Prebisch and Hans Singer hypothesized that over time, the price of primary commodities such as agricultural products and minerals would decline relative to the price of manufactured goods. The decline of primary commodities would lead to a worsening of the terms of trade for developing countries, the source of most of these products. The three graphs in Figure 2-12 show that the relative price of primary commodities has increased, decreased, and remained roughly the

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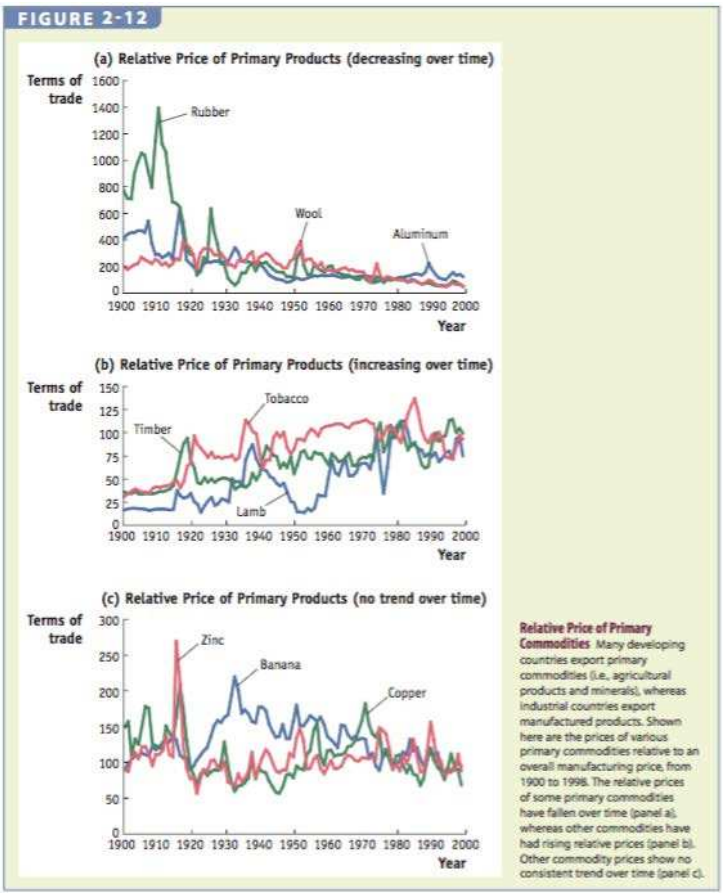
same over time, depending on the product traded.



5 Conclusion

The Ricardian model consists of the simple concept that the pattern of trade is determined by comparative advantage. By exporting the good in which a country has the lowest opportunity cost relative to producing another good, the country could benefit from participating in international trade by consuming at a higher level of utility than it would under no trade. In addition, the Ricardian model also shows that wages across countries are determined by absolute advantage, in which the country

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possessing the more advanced technology will enjoy higher real wages. Another result of the Ricardian model is that a small country will gain from trading with a large country, but the larger country will neither gain nor lose from the trade. The reason is because the international equilibrium price ratio will equal the large country's relative no-trade prices.

TEACHING TIPS

Tip 1: Comparative Advantage

Comparative advantage is perhaps the most important concept in international trade. Therefore, it warrants substantial treatment in this course. Ask students to break into groups or work on their own to come up with additional example of comparative advantage that need not relate to *international trade*. Discussing examples, such as lawyers paying landscapers to mow their lawns, may help students better grasp the concept.

Tip 2: An Introduction to Trade Data

To familiarize students with international trade data and sources, have students explore the part of the United States International Trade Commission website that accesses trade data (http://dataweb.usitc.gov/prepared_reports.asp). Direct students to explore U.S. trade balances sectors, noting any trends they might find. Ask them to consider what role comparative advantage might play in the trends they observe.

Tip 3: Individual Products, Trade Flows, and Comparative Advantage

Yet another way to engage students in empirical international trade is to ask them to look up specific

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goods and the United States' major trading partners. Have your class go to the website of the International Trade Administration at the U.S. Department of Commerce (http://www.trade.gov/mas/ian/otii/index.asp). Students can then follow the TradeStatsExpress link (scroll down and click on the icon), next click on National Trade Data, and finally click on Global Patterns of U. S. Merchandise Trade.

Here, students can pick their own goods to investigate U.S. imports, exports, and trade balance. Ask them to look up a good they expect the United States to have a comparative advantage or disadvantage in and to test their beliefs with current data.

Some examples of goods and their harmonized system codes follow. After students click the "Change" button under "Product," tell them to be sure to click the "HS Radio" button before they look for "HS Codes." To enter the six-digit codes below, they will need to click the "Product Code" tab in the "Select Products for Report" dialog box.

Harmonized System Codes (HS Codes)	**Product Description**
880240	Airplanes and other aircraft, of an unladen weight exceeding 15,000 kilograms
480300	Toilet or facial tissue stock, towel or napkin stock and similar paper of a kind used for household or sanitary purposes, cellulose wadding and webs
660110	Garden or similar umbrellas

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Harmonized System Codes (HS Codes)	Product Description
920300	Keyboard pipe organs; harmoniums and similar keyboard instruments with free metal reeds
180100	Cocoa beans (whole or broken)

IN-CLASS PROBLEMS

1. What determines the pattern of international trade between two countries in the Ricardian model?

Answer: The pattern of trade is determined by comparative advantage. The country with a comparative advantage in the production of a product will export the good.

2. Using the Ricardian model, explain why American workers receive higher wages in the production of automobiles than Chinese workers.

Answer: American automobile workers receive higher wages than Chinese automobile workers because the United States has an absolute advantage in the production of many goods, including automobiles.

3. Why is the production possibilities frontier a straight line in the Ricardian model?

Answer: The production possibilities frontier is a straight line in the Ricardian model because of the assumption that the marginal products of labor are constant. The Ricardian model ignores the role of

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land and capital, so there are no diminishing returns.

4. Refer to the following table and assume that the total labor supply in Taiwan is 4 and the total labor supply in Vietnam is 8.

	Taiwan	**Vietnam**	**Absolute Advantage**
Number of telephones produced per hour	10	5	?
Number of radios produced per hour	50	10	?
Comparative advantage	?	?	

a. What is the opportunity cost of 1 unit of telephones in terms of radios in Taiwan? In Vietnam?

Answer: See the following table.

	Opportunity Cost of	
	1 Telephone (in Terms of Units of Radio Given Up)	**1 Radio (in Terms of Units Telephone Given Up)**

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Taiwan	5	$\frac{1}{5}$
Vietnam	2	$\frac{1}{2}$

b. Determine whether each of the following statements is true or false. Provide a brief explanation of why it is true or false.

i. Taiwan has an absolute advantage in the production of both telephones and radios.

Answer: TRUE: Taiwan can produce more of both goods per hour than Vietnam.

ii. Vietnam has a comparative advantage in the production of telephones.

Answer: TRUE: Vietnam has a lower opportunity cost of producing telephones relative to Taiwan.

iii. One possible production combination for Vietnam is 40 units of telephone and 80 units of radio per hour.

Answer: FALSE: With a labor supply of 8, it is not possible for Vietnam to produce 40 units of telephone *and* 80 units of radio in an hour. Instead, two possible production combinations include $MPL_T^{Viet} \cdot \overline{L^*} = 5 \cdot 8 = 40$ units of telephone per hour *or* $MPL_R^{Viet} \cdot \overline{L^*} = 10 \cdot 8 = 80$ units of radio per hour.

c. If the two countries engage in international trade, what will Taiwan produce and how many?

Answer: Because Vietnam has the lower opportunity cost in the production of telephones and hence comparative advantage in producing this good, Taiwan has a comparative advantage in the production of radios. Thus, Taiwan will specialize in the production of radios. Taiwan will produce $50 \cdot 4 = 200$ per hour.

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d. What is the real wage in Taiwan in terms of radio? What is the real wage in Vietnam in terms of telephone?

Answer: The real wage in Taiwan in terms of radio is $MPL_R^{Tai} = 50$units of radio. The real wage in Vietnam in terms of telephone is $MPL_T^{Viet} = 5$ units of telephone.

e. Will Taiwan and Vietnam trade if the international relative price of telephone is 3? Briefly explain why or why not.

Answer: Because the no-trade prices are $P_T^{Tai} / P_R^{Tai} = 5$ in Taiwan and $\frac{P_T^{Viet}}{P_R^{Viet}} = 2$ in Vietnam, two countries will engage in trade if the international relative price of telephone is 3. In particular, Vietnam will export telephones because the international relative price of telephone is higher than its no-trade equilibrium price. By contrast, Taiwan will import telephones because the international relative price of telephone is lower than its no-trade equilibrium price.

5. Refer to the following table in answering the questions that follow. Assume each country has 100 laborers.

	Australia	**United States**	**Absolute Advantage**
Pounds of beef produced per hour	17	35	?
Bushels of wheat	51	105	?

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produced per hour			
Comparative advantage	?	?	

a. Which country has an absolute advantage in the production of wheat?

Answer: The United States has an absolute advantage in the production of wheat because it can produce 105 pounds of wheat per hour, whereas Australia can produce 51 pounds in the same hour.

b. Using the Ricardian model, would trade between Australia and the United States be mutually beneficial? Briefly explain why or why not.

Answer: Australia and the United States will not engage in trade because there are no differences in opportunity costs between the two countries, so there are no opportunities to gain from trade according to the Ricardian model.

	Opportunity Cost of	
	1 Pound of Beef (in Terms of Bushels of Wheat Given Up)	**1 Bushel of Wheat (in Terms of Pounds of Beef Given Up)**
Australia	3	$\frac{1}{3}$

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United States	3	$\frac{1}{3}$

6. Would your answers to Problem 5 be different if a worker in the United States became more productive and could produce 70 pounds of beef or 140 bushels of wheat per hour?

Answer: With the increase in productivity in the United States, the two countries now have differences in opportunity costs and will find trade mutually beneficial.

	Opportunity Cost of	
	1 Pound of Beef (in Terms of Bushels of Wheat Given Up)	**1 Bushel of Wheat (in Terms of Pounds of Beef Given Up)**
Australia	3	$\frac{1}{3}$
United States	2	$\frac{1}{2}$

7. Answer the questions below using the information given in the following table.

	China	**France**
Pairs of boots produced per hour	4	8
Bottles of wine produced per	2	16

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hour		
Comparative advantage	?	?

a. Which country has a comparative advantage in the production of boots?

Answer: China has a comparative advantage in producing boots because it has a lower opportunity cost in producing boots ($MPL_B^{China} / MPL_W^{China} = \frac{1}{2} < MPL_B^{France} / MPL_W^{France} = 2$).

b. Provide the range of the international relative price of wine at which the two countries would trade.

Answer: The range of the international relative price of wine at which the two countries would trade would be between their no-trade relative prices, which are $P_W^{China} / P_B^{China} = 2$ and $P_W^{France} / P_B^{France} = \frac{1}{2}$ in China and France, respectively.

c. Suppose that researchers in France discover a new technology that doubles the marginal product of labor in boots. Would China and France continue to trade? Briefly explain why.

Answer: Although the new technology would allow workers in France to be more productive, and thus earn higher wages, France will continue to trade with China as long as there are differences in opportunity costs between the two countries.

8. Some Americans fear that as countries such as China and India become more productive in industries such as computers and computer programming, once dominated by the United States, the wages of workers in the United States will fall. Should U.S. workers fear foreign competition for this reason according to the Ricardian model? Briefly explain why or why not.

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Answer: Suppose the initial productivity in China and the United States is given by the first two columns in the table below. In this case, the United States has an absolute advantage in the production of both computer programs (programs) and wheat. China has a comparative advantage in producing wheat, whereas the United States has a comparative advantage in the production of computer programs.

	Initial		**New**	
	China	**United States**	**China**	**United States**
Numbers of programs produced per hour	1	10	5	10
Bushels wheat produced per hour	10	50	10	50

	***Initial* Opportunity Cost of**	
	1 Number of Programs (in Terms of Bushels of Wheat Given Up)	**1 Bushel of Wheat (in Terms of Numbers of Program Given Up)**
China	10	1/10
United States	5	1/5

Suppose that the world relative price of computer programs is 8. Then the initial U.S. wage is given

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by

MPL_p = 10 numbers of program

Initial U.S. wage = *or*

$(P_p/P_W) \cdot MPL_p$ = 80 bushels of wheat

Let's assume that China becomes more productive in producing computer programs although everything else remains constant, as given by the last two columns on the right in the above table. Now China has a comparative advantage in producing computer programs.

	***New* Opportunity Cost of**	
	1 Number of Programs (in Terms of Bushels of Wheat Given Up)	**1 Bushel of Wheat (in Terms of Numbers of Program Given Up)**
China	2	$\frac{1}{2}$
United States	5	$\frac{1}{5}$

Suppose the new world relative price of computer program is 4

$(P_W/P_p) \cdot MPL_W$ = 12.5 numbers of program

New U.S. wage = *or*

MPL_W = 50 bushels of wheat

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This example shows that when China increases productivity in computer programming, wages of workers in the United States fall in terms of wheat and rise in terms of computer programs. The gain in terms of number of computer programs results from the lower world relative price of computer programs.

9. Refer to the following table. Assume there are two workers in Mexico and three workers in the United States.

	Mexico **Labor = 2**	**United States** **Labor = 3**
Bottles of tequila produced per hour	7	5
Pounds of rice produced per hour	5	10
Comparative advantage	?	?

a. Determine the pre-trade relative price of tequila in Mexico and the United States.

Answer: The pre-trade relative price of tequila in Mexico and the United States are $\frac{MPL_R}{MPL_T} = P_T^{Mexico} / P_R^{Mexico} = 5/7$ and $\frac{MPL_R}{MPL_T} = P_T^{US} / P_R^{US} = 2$ in Mexico and the United States, respectively.

b. Given your answer in part (a), which country has a comparative advantage in the production of rice?

Answer: The United States has a comparative advantage in producing rice.

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c. What is the lowest international relative price of tequila Mexico is willing to accept to engage in trade with the United States? Briefly explain why.

Answer: The international relative price of tequila must be at least $\frac{5}{7}$ for Mexico to engage in trade. This is because Mexico's no-trade relative price of tequila is $\frac{5}{7}$.

10. Use the information provided in Problem 9, but suppose the number of laborers in the United States is 300, while the number of laborers in Mexico remains the same at 2.

a. Determine the terms of trade for the United States.

Answer: The United States exports rice, so its term of trade is the price of its exports over the price it receives for its imports = P_R/P_T.

b. Which country gains more from trade? Briefly explain why.

Answer: Given the relative size of the two countries, the world relative price will be closer to the no-trade relative price of tequila in the United States so that Mexico gains more from trade.

11. Provide an example of how the mercantilist school of thought continues to exist today.

Answer: The mercantilist school of thought continues to exist in countries such as the United States in which certain groups favor limiting imports while pushing for exports.

12. Suppose there are two countries producing two goods using only labor. Refer to the following table to answer the questions.

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	Italy	**France**	**Absolute Advantage**
Pairs of shoes produced per hour	6	3	?
Bottles of wine produced per hour	2	1	?
Comparative advantage	?	?	

a. Which country has absolute advantage in the production of shoes? Wine?

Answer: Italy has an absolute advantage in the production of shoes and wine.

b. Which country has a comparative advantage in the production of shoes? Wine?

Answer: Because the countries have the same opportunity costs in terms of shoes, neither country has a comparative advantage in the production of shoes. The same goes for the production of wine.

c. Does Italy gain from trading with France? Briefly explain why or why not using the Ricardian model.

Answer: Without differences in opportunity costs, there are no gains from trade according to the Ricardian model.

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2

Trade and Technology: The Ricardian Model

Questions to Consider

1. **What are reasons for countries to trade?**
2. **Will the country that is best at producing a good always export it?**
3. **How can countries compete with low-wage exporters, like China?**

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Introduction

Doug Pensinger/Getty Images

Where did Jamie Anderson's snowboard come from?

In 2014 the United States **imported** (i.e., purchased from other countries) $28 million of snowboards from 18 different countries.

China **exported** (i.e., sold to another country) nearly $13 million worth of snowboards to the United States in 2014.

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Introduction

Table 2-1 shows that the U.S. imported 350,600 snowboards from 18 countries in 2014 that were worth more than $28 million.

This pattern raises a question: With all the manufacturing capability in the United States, why does it purchase snowboards from these countries at all instead of producing them domestically?

TABLE 2-1 U.S. Imports of Snowboards, 2014

Rank	Country	Value of Imports ($ thousands)	Quantity of Snowboards (thousands)	Average Price ($/board)
1	China	12,991	210.5	62
2	Austria	9,981	75.3	133
3	United Arab Emirates	2,402	16.4	147
4	Taiwan	2,060	29.0	71
5	Canada	276	15.7	18
6	Switzerland	203	1.1	183
7	Germany	106	1.0	103
8	Slovenia	32	0.3	112
9	Netherlands	32	0.3	104
10	France	32	0.1	234
11	Tunisia	22	0.2	128
12	Slovak Republic	11	0.1	122
13–18	All other countries	23	0.6	41
	Total	28,172	350.6	80

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Introduction

In this chapter, we will:

- Learn the reasons countries trade
- Distinguish between **absolute** and **comparative advantage**
- Understand the **Ricardian model**
- Understand the no-trade equilibrium using each country's PPF and **indifference curve**
- Solve for wages across countries
- Solve for **international prices**
- Derive the home **export supply** and Foreign **import demand curve** and how to arrive at **international trade equilibrium**

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Introduction

Reasons countries trade goods with each other

- Differences in the **technology** used in each country (i.e., 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 **offshoring** (i.e., 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 (i.e., how close they are to one another)

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Introduction

In this chapter, we focus on technology differences across countries as an explanation for trade, called the Ricardian model.

- The Ricardian model explains how the level of a country's technology affects its **trade pattern**.
- It also explains the concept of comparative advantage and why it works as an explanation for trade patterns.

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1 Reasons for Trade

Proximity

- The closer countries are, the lower the costs of transportation. For example, the largest trading partner of most European countries is another European country.

Resources

- Geography includes **natural resources**, as well as **labor resources** and **capital**. A country's resources are often collectively called its **factors of production**, the land, labor, and capital used to produce goods and services.

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1 Reasons for Trade

Absolute Advantage

- When a country has the best technology for producing a good, it has an **absolute advantage** in the production of that good.
- Absolute advantage is not a good explanation for trade patterns.

Comparative Advantage

- Instead, **comparative advantage** is the primary explanation for trade among countries.
- A country has comparative advantage in producing those goods that it produces best *compared with* how well it produces other goods.

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Comparative Advantage

AP Photo/Julie Jacobson

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

- In some cases, a country can export a good without having any advantage in the natural resources needed to produce it.
- One example is "icewine," which is a type of wine invented in Germany but which is now also produced in the Niagara Falls region of Canada and the United States.

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David Ricardo and Mercantilism

Bettman/Corbis

- **Mercantilists** believed that exporting was good because it generated gold and importing was bad because it drained gold from the national treasury.
- Mercantilists were in favor of high tariffs to ensure high exports and low imports.
- Ricardo showed that countries could benefit from international trade without having to use tariffs.
- Many of today's major international institutions around the world were founded at least in part on the idea that free trade between countries brings gains for all trading partners.

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The Home Country

To develop a Ricardian model of trade, we will use an example with two goods:

- Wheat and other grains are major exports of the United States and Europe.
- Many types of cloth are imported into these countries.

For simplicity, we ignore the role of land and capital and suppose that both goods are produced with labor alone.

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The Home Country

We assume that labor is the only resource used to produce goods. The **marginal product of labor (MPL)** is the extra output obtained by using one more unit of labor.

- In Home, one worker produces 4 bushels of wheat, so $MPL_W = 4$.
- Alternatively, one worker can produce 2 yards of cloth, so $MPL_C = 2$.

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The Home Country

Home Production Possibilities Frontier

- We can graph Home's **production possibilities frontier** (PPF) using the marginal products for wheat and cloth.
- The slope of the PPF is also the **opportunity cost** of wheat, the amount of cloth that must be given up to obtain one more unit of wheat.
- If Home had 25 workers and all were employed in wheat, Home could produce 100 bushels. If all were employed in cloth, they could produce 50 yards.

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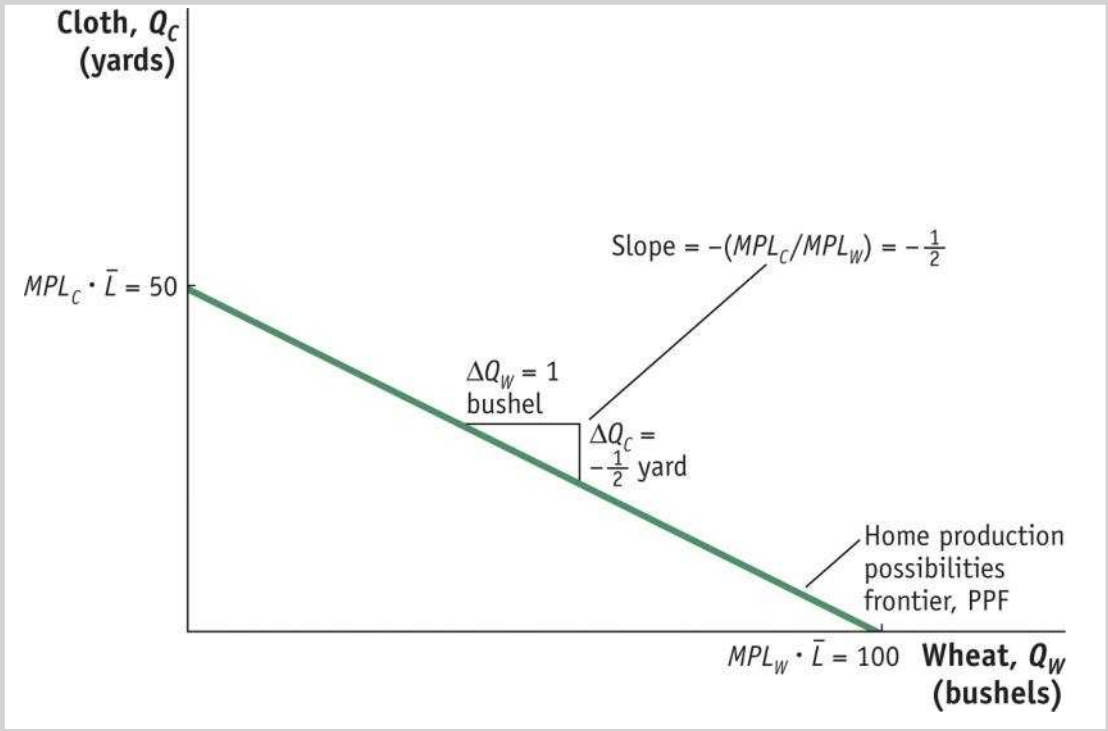
The Home Country

Home Production Possibilities Frontier

FIGURE 2-1



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. Equivalently, the magnitude of the slope can be expressed as the ratio of the marginal products of labor for the two goods.

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

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The Home Country

Home Indifference Curve

We will represent demand in the Home economy using indifference curves that have the following properties:

- All points on an indifference curve have the same level of **utility**.
- Points on higher indifference curves have higher utility.
- 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.

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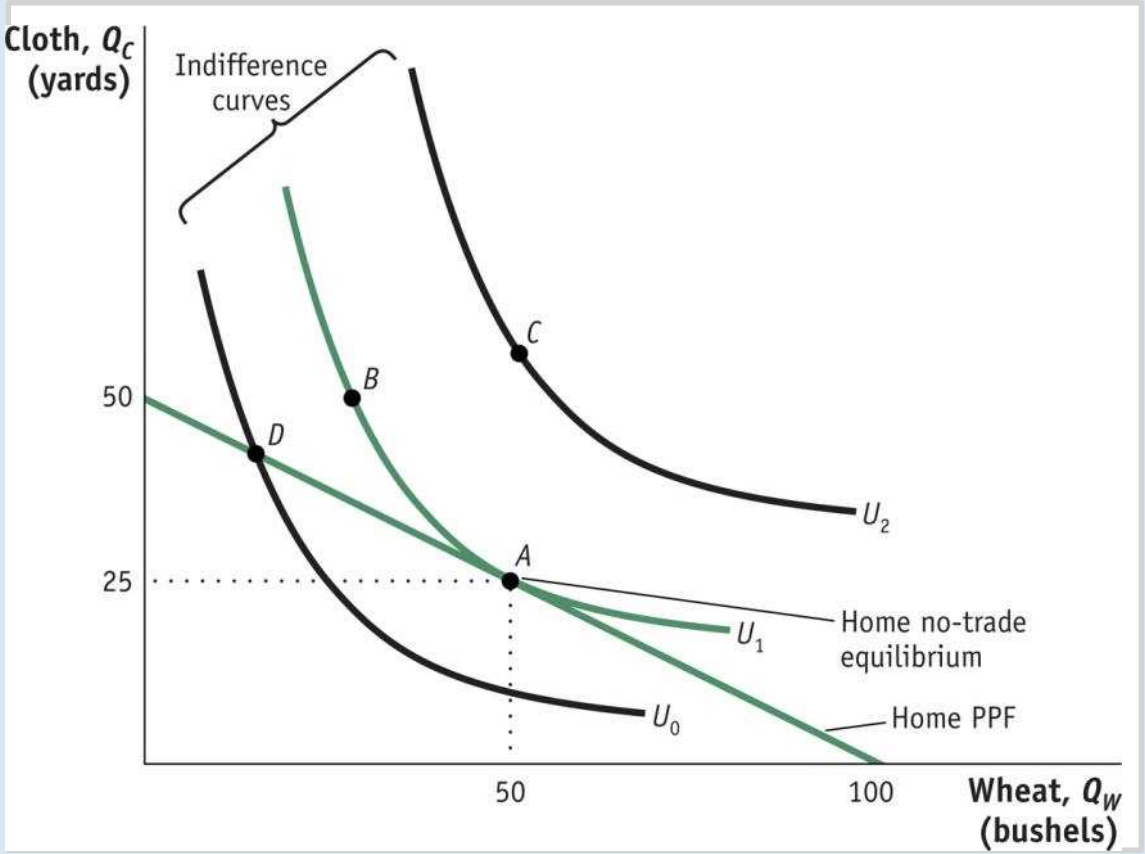
Home Indifference Curve

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.

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The Home Country

Opportunity Cost and Prices

- 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.
- *Price reflects the opportunity cost of a good.*

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The Home Country

Wages

- In competitive markets firms hire workers up to the point at which the hourly wage equals the value of one more hour of production.
- The value of one more hour of labor equals the amount of goods produced in that hour (MPL) times the price of the good.
- Labor will be hired up to the point where wage equals $P \bullet MPL$ for each industry.

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The Home Country

Wages

- Use the equality of the wage across industries to obtain the following equation:

$$P_W \bullet MPL_W = P_C \bullet MPL_C$$

- Rearranging terms, we see that

$$P_W/P_C = MPL_C/MPL_W$$

- The right-hand side of the equation is the slope of the production possibilities frontier (the opportunity cost of one more bushel of wheat).
- The left-hand side of the equation is the relative price of wheat.

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The Foreign Country

- Assume a Foreign worker can produce one bushel of wheat or one yard of cloth.

$$MPL^*_W = 1,\ MPL^*_C = 1$$

- Assume there are 100 workers available in Foreign.
- If all workers were employed in wheat, they could produce 100 bushels.
- If all workers were employed in cloth, they could produce 100 yards.
- It is worth noting that Home country has absolute advantage in both goods, but will export only one as explained later.

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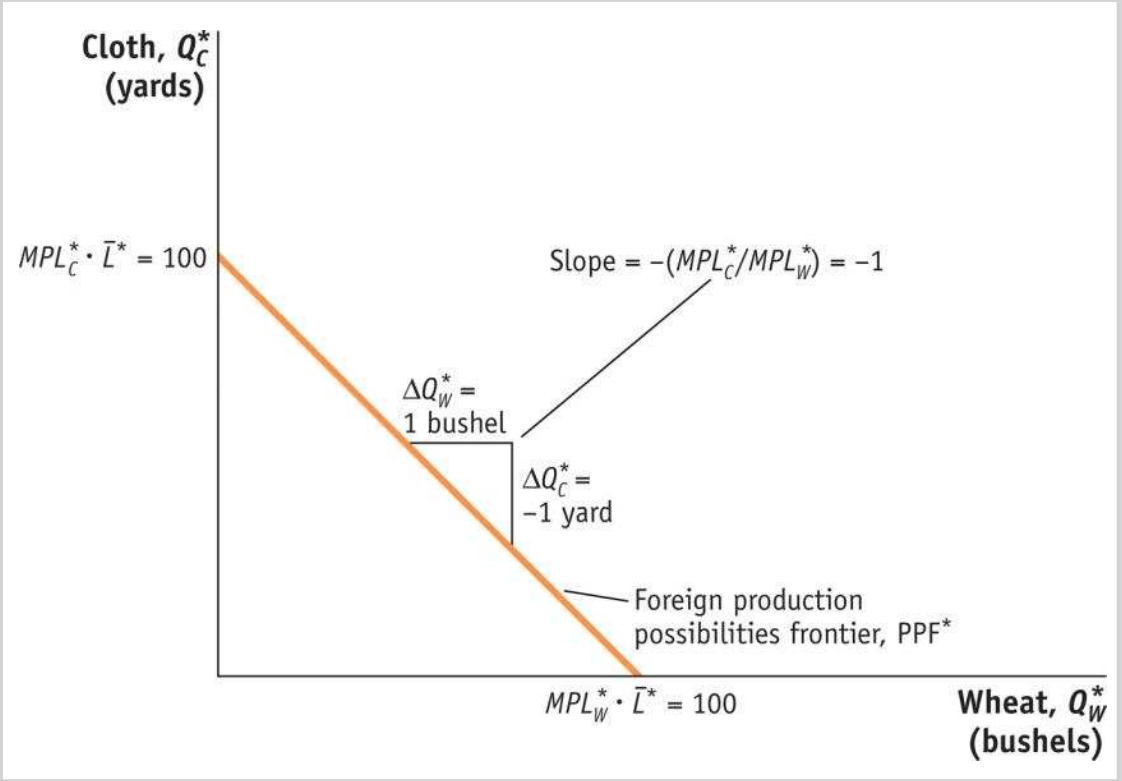
The Foreign Country

Foreign Production Possibilities Frontier

FIGURE 2-3



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.

The opportunity cost is the amount of cloth that must be given up (1 yard) to obtain 1 more bushel of wheat.

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Comparative Advantage

	Cloth (1 Yard)	Wheat (1 Bushel)
Home	2 Bushels of Wheat	½ Yard of Cloth
Foreign	1 Bushel of Wheat	1 Yard of Cloth

- A country has a comparative advantage in a good when it has a lower opportunity cost of producing than another country.
- By looking at the chart we can see that Foreign has a comparative advantage in producing cloth. Home has a comparative advantage in producing wheat.

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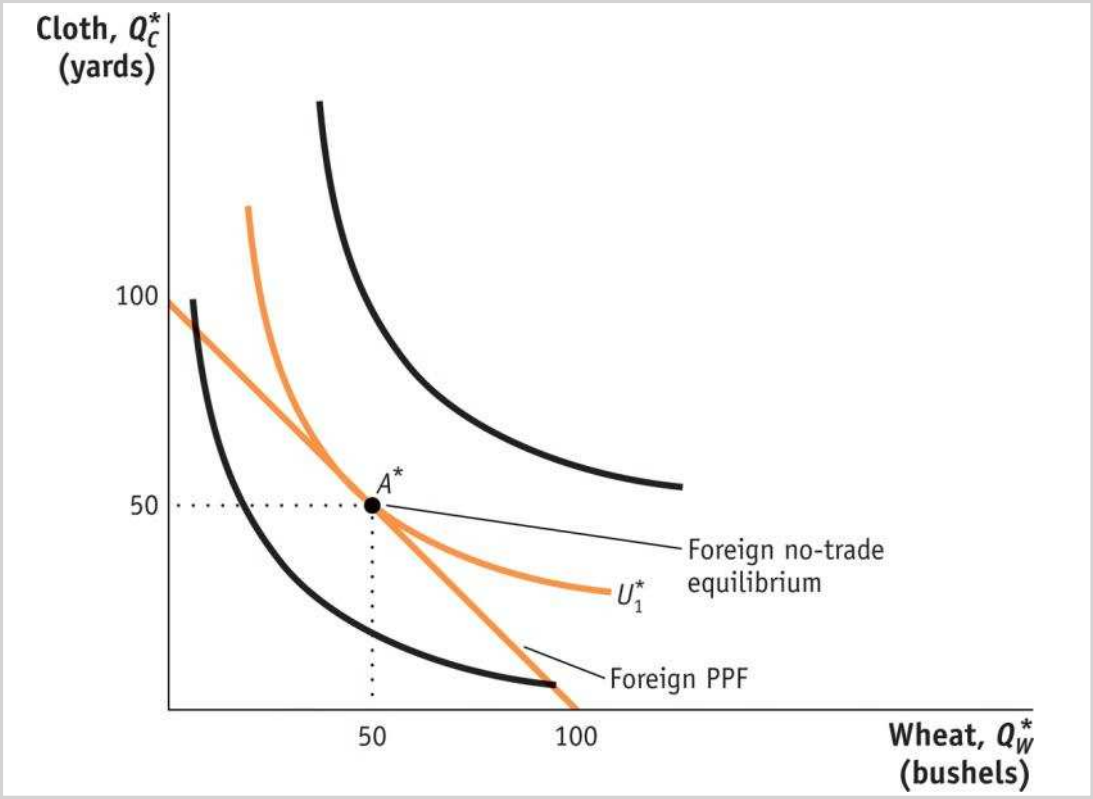
The Foreign Country

Comparative Advantage

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.

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APPLICATIONS

Comparative Advantage in Apparel, Textiles, and Wheat

TABLE 2-2 Apparel, Textiles, and Wheat in the United States and China

This table presents 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, but it has a comparative advantage in producing wheat.

	United States	China	Absolute Advantage
	Sales/Employee	*Sales/Employee*	*U.S./China Ratio*
Apparel	$70,000	$27,000	2.6
Textiles	$232,000	$20,000	12
	Bushels/Worker	*Bushels/Worker*	*U.S./China Ratio*
Wheat	10,000	300	33
	Comparative Advantage		
	Bushels/$	*Bushels/$*	
Wheat/apparel ratio	0.14	0.01	
Wheat/textile ratio	0.04	0.01	

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International Trade Equilibrium

What happens when goods are traded between Home and Foreign? We will see:

- That a country's no-trade relative price determines which product it will export and which it will import
- The no-trade relative price equals its opportunity cost of production
- The pattern of exports and imports will be determined by the opportunity costs of production in each country—*their comparative advantage*

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International Trade Equilibrium

Examining each country's no-trade relative price, we can determine which product it will export and which it will import.

- The relative price of cloth in Foreign is $P_C/P_W = 1$.
- The relative price of cloth in Home is $P_C/P_W = 2$.
- Therefore, Foreign would want to export cloth to Home they can make it for \$1 and export it for more than \$1.
- Home will export wheat and Foreign will export cloth.

Both countries export the good for which they have the comparative advantage.

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International Trade Equilibrium

The two countries are in an international trade equilibrium when the relative price of wheat is the same in the two countries.

To fully understand the international trade equilibrium, we are interested in two issues:

- Determining the relative price of wheat (or cloth) in the trade equilibrium
- Seeing how the shift from the no-trade equilibrium to the trade equilibrium affects production and consumption in both Home and Foreign.

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International Trade Equilibrium

- The relative price of wheat in the trade equilibrium will be between the no-trade price in the two countries.
- For now assume the free-trade price of P_W/P_C is $\frac{2}{3}$ (between the price of $\frac{1}{2}$ in Home and 1 in Foreign).
- We can now take this price and see how trade changes production and consumption in each country.
- The **world price line** shows the range of *consumption possibilities* that a country can achieve by specializing in one good and engaging in international trade.

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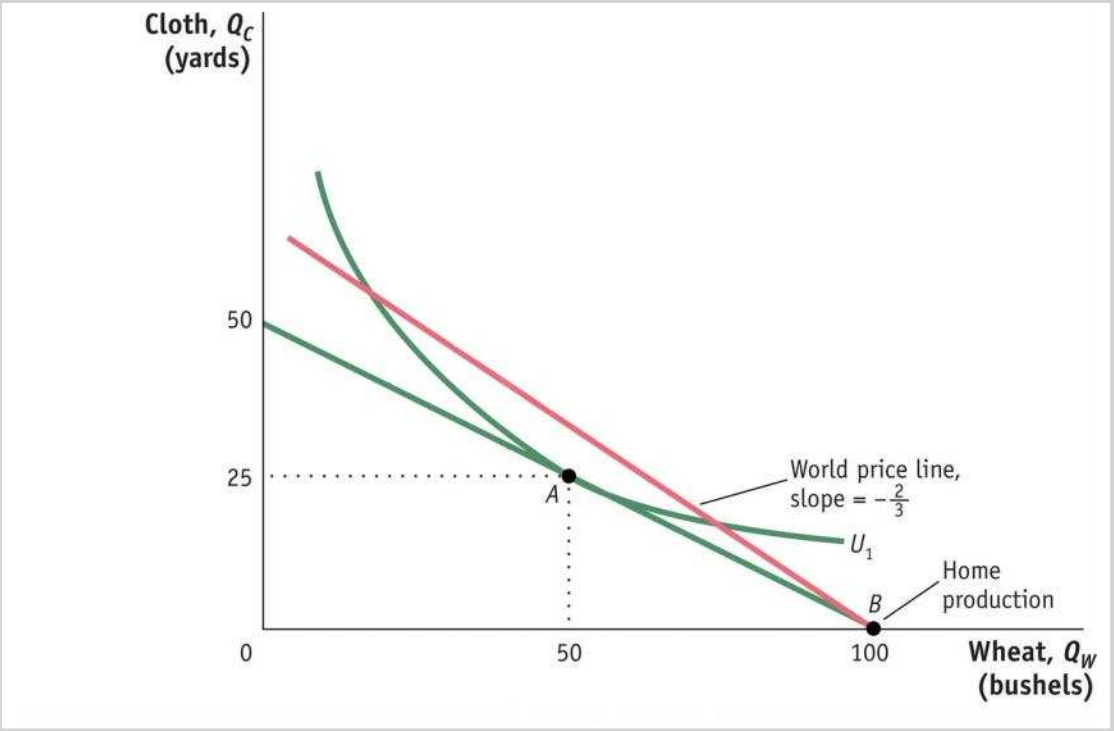
International Trade Equilibrium

Change in Production and Consumption

FIGURE 2-5 (1 of 3) Home Equilibrium with Trade



With a world relative price of wheat of $^2/_3$, 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.

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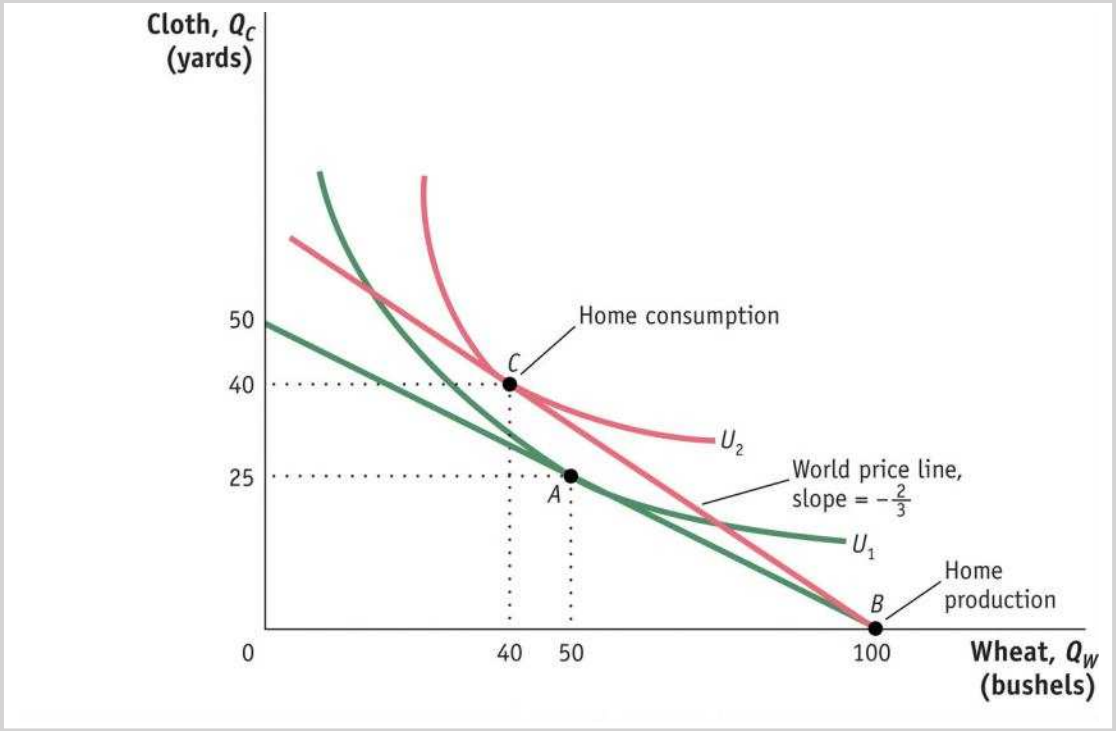
International Trade Equilibrium

Change in Production and Consumption

FIGURE 2-5 (2 of 3) Home Equilibrium with Trade (continued)



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.

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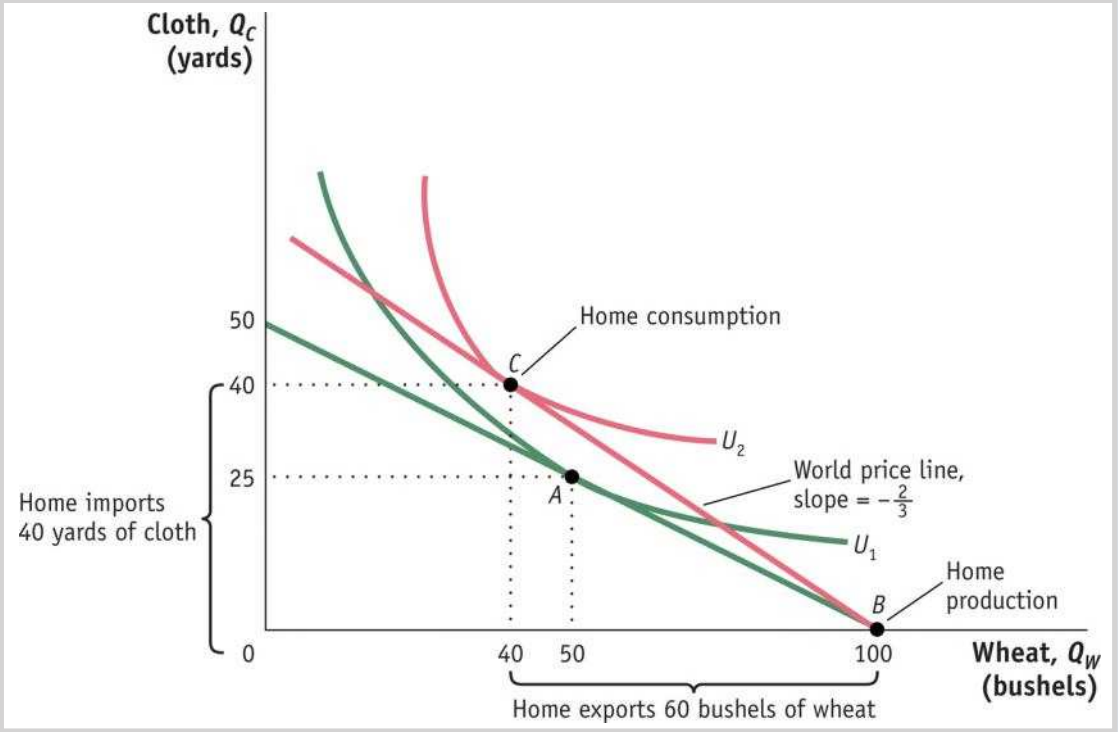
International Trade Equilibrium

Change in Production and Consumption

FIGURE 2-5 (3 of 3) Home Equilibrium with Trade (continued)



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 pre-trade levels.

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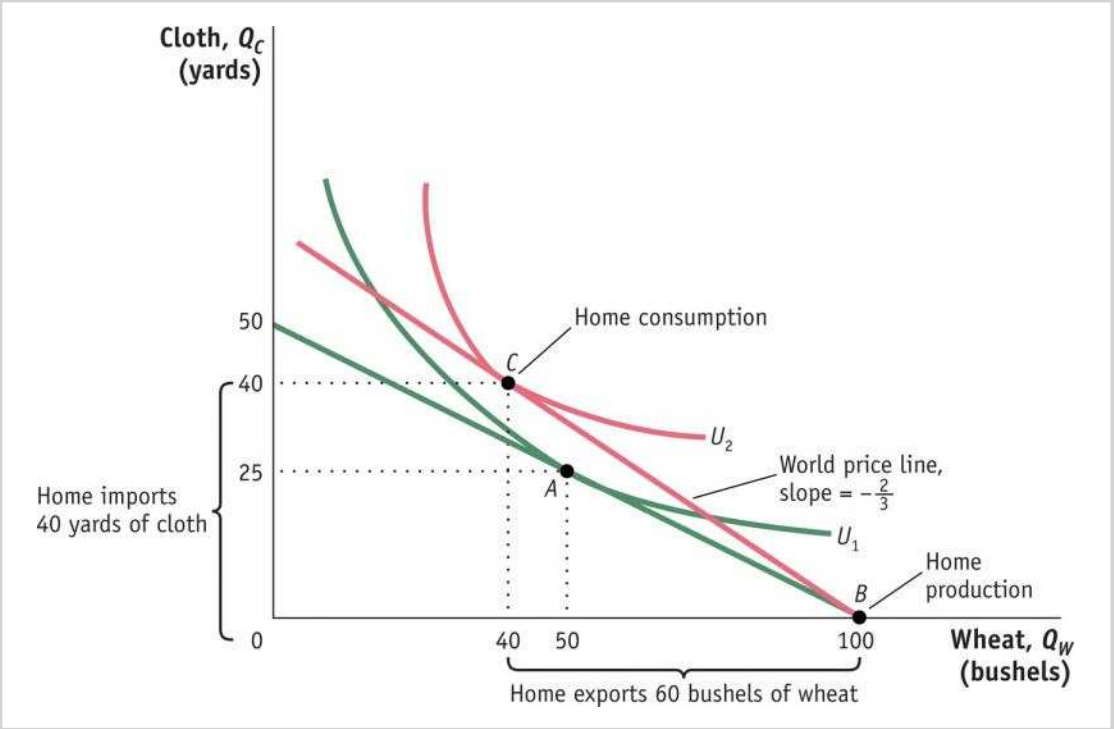
International Trade Equilibrium

FIGURE 2-5 (revisited) Home Equilibrium with Trade



International Trade

Home obtains a higher utility with international trade than in the absence of 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**.

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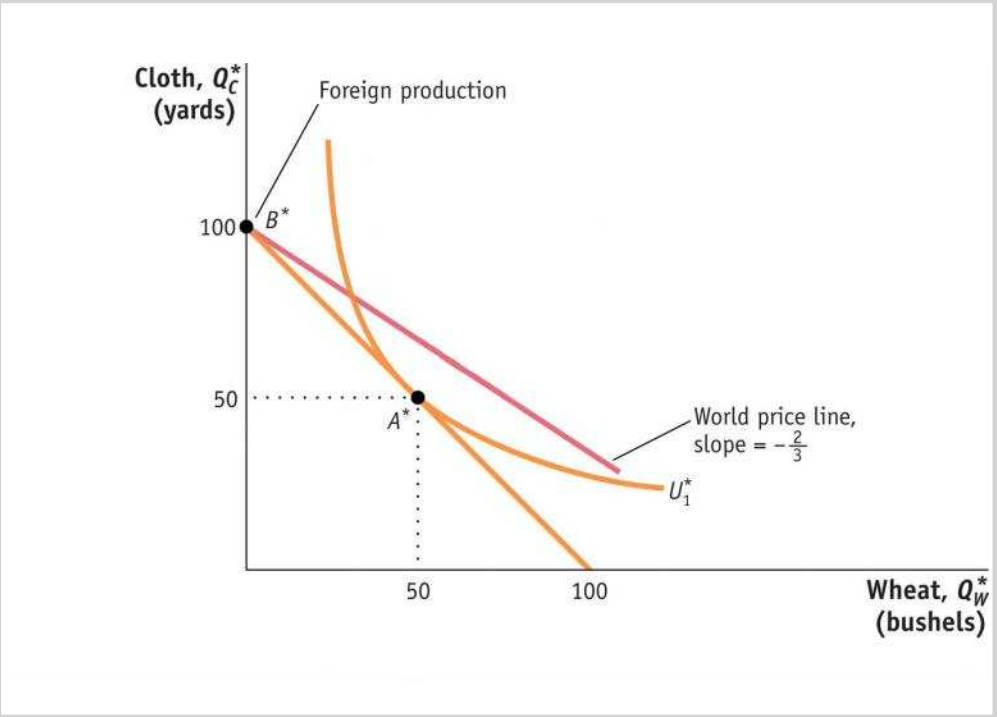
International Trade Equilibrium

Pattern of Trade and Gains from Trade

FIGURE 2-6 (1 of 2) Foreign Equilibrium with Trade



With a world relative price of wheat of $^2/_3$, Foreign production will occur at point B^*.

Through international trade, Foreign is able to export $^2/_3$ yard of cloth in exchange for 1 bushel of wheat, moving down the world price line.

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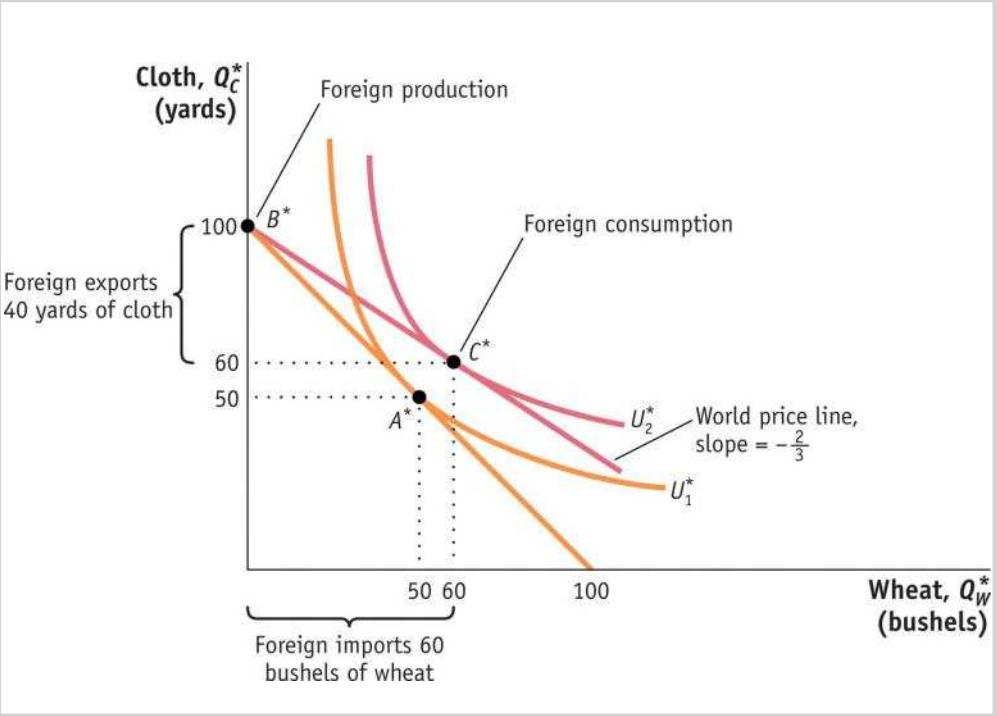
International Trade Equilibrium

Pattern of Trade and Gains from Trade

FIGURE 2-6 (2 of 2) Foreign Equilibrium with Trade (continued)



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 pre-trade wheat and cloth consumption (point A^*), Foreign consumes 10 more bushels of wheat and 10 more yards of cloth.

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Pattern of Trade and Gains from Trade

Each country is exporting the good for which it has the comparative advantage.

- This confirms that the pattern of trade is determined by comparative advantage.
- This is the first lesson of the Ricardian model.

There are gains from trade for both countries.

- This is the second lesson of the Ricardian model.

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Solving for Wages Across Countries

$$\text{Home Wage} = \begin{cases} MPL_w = 4 \text{ bushels of wheat} \\ or \\ \left({}^{P_w}/_{P_c}\right).\, MPL_w = \frac{8}{3} \text{ yard of cloth} \end{cases}$$

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

Absolute Advantage

As our example shows, wages are determined by absolute advantage. In contrast, the pattern of trade is determined by comparative advantage.

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Solving for Wages Across Countries

- In competitive labor markets, firms will pay workers the value of their marginal product.
- Home produces and exports wheat; therefore, they will be paid in terms of that good—the real wage is $MPL_W = 4$ bushels of wheat.
- The workers sell the wheat on the world market at a relative price of $P_W/P_C = 2/3$.
- We can use this to calculate the real wage in terms of cloth: $(P_W/P_C)MPL_W = (2/3)4 = 8/3$ yards.

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Solving for Wages Across Countries

- We can do this for Foreign as well and summarize:

  Home real wage is:

  - 4 bushels of wheat or 8/3 yards of cloth

  Foreign real wage is:

  - 3/2 bushels of wheat or 1 yard of cloth

- Foreign workers earn less than Home workers as measured by their ability to purchase either good. (The foreign real wages are still higher compare to autarky.)

- This reflects Home's absolute advantage in the production of both goods.

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APPLICATION

Labor Productivity and Wages

FIGURE 2-7

Labor Productivity and Wages, 2011 Labor productivity is measured by value-added per hour of work and can be compared with the wages paid in manufacturing in various countries.

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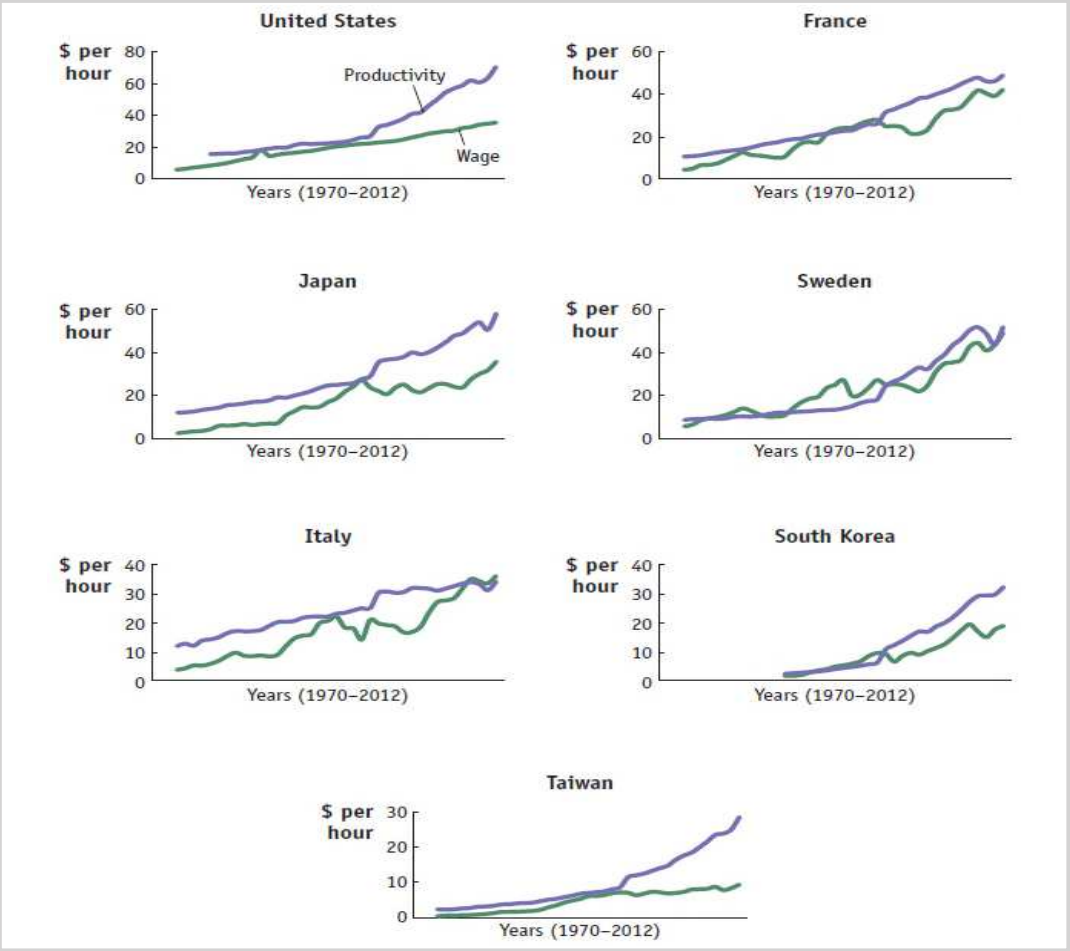
Application

Labor Productivity and Wages

FIGURE 2-8



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.

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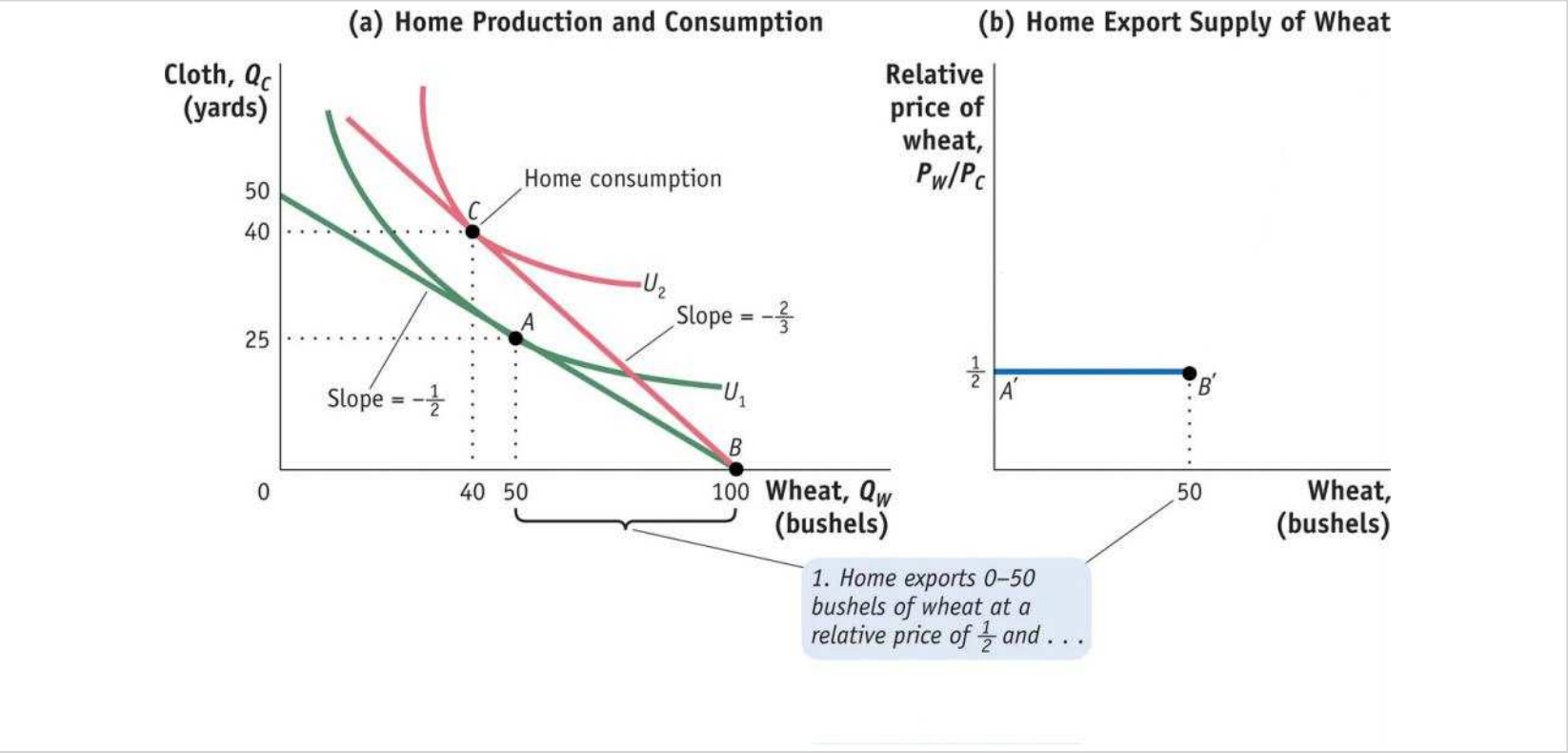
4 Solving for International Prices

Home Export Supply Curve

FIGURE 2-9 (1 of 2)



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.

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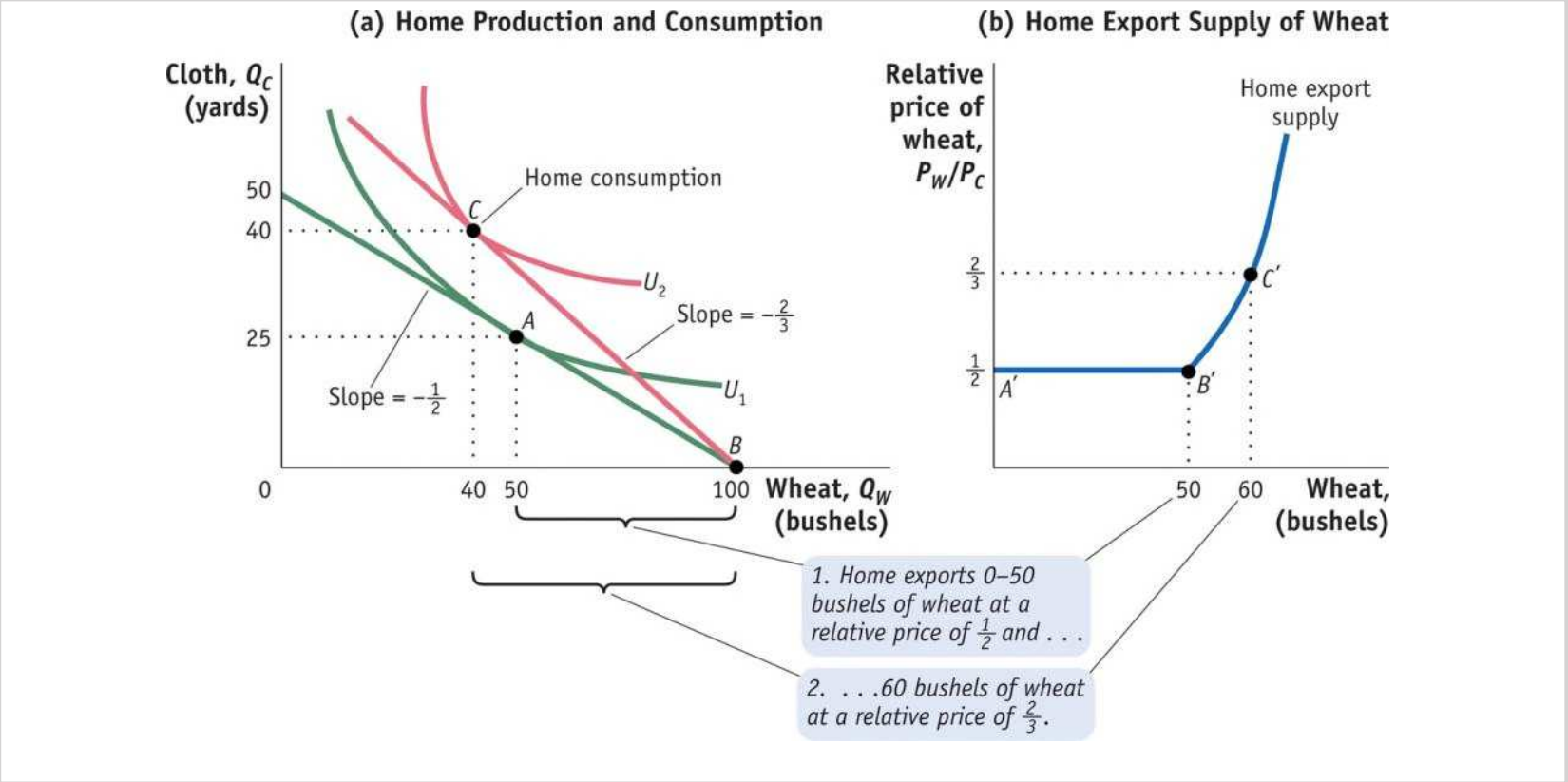
4 Solving for International Prices

Home Export Supply Curve

FIGURE 2-9 (2 of 2)



Home Export Supply (continued) For relative prices above $^1/_2$, Home exports more than 50 bushels, along the segment $B'C'$. For example, at the relative price of $^2/_3$, Home exports 60 bushels of wheat.

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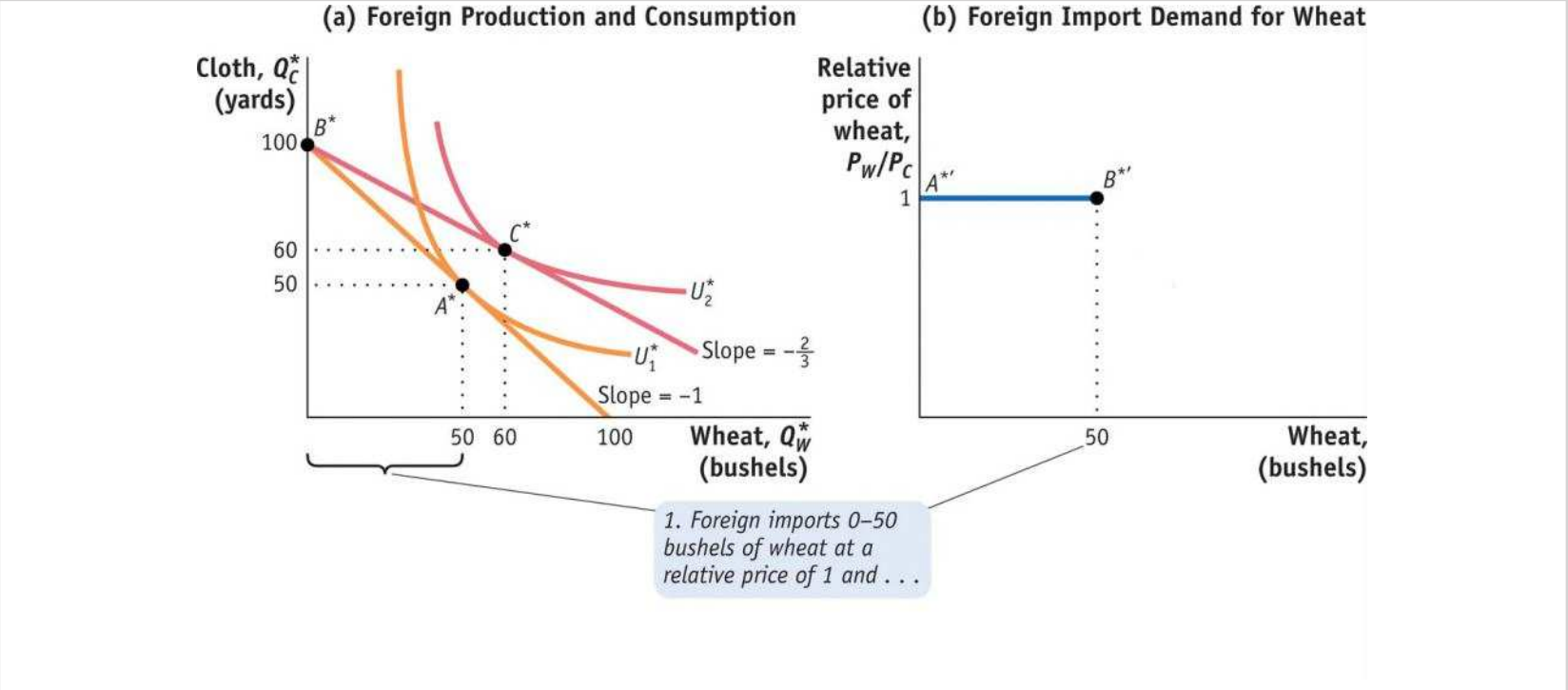
4 Solving for International Prices

Foreign Import Demand Curve

FIGURE 2-10 (1 of 2)



Foreign Import Demand Panel (a) repeats Figure 2-6. 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.

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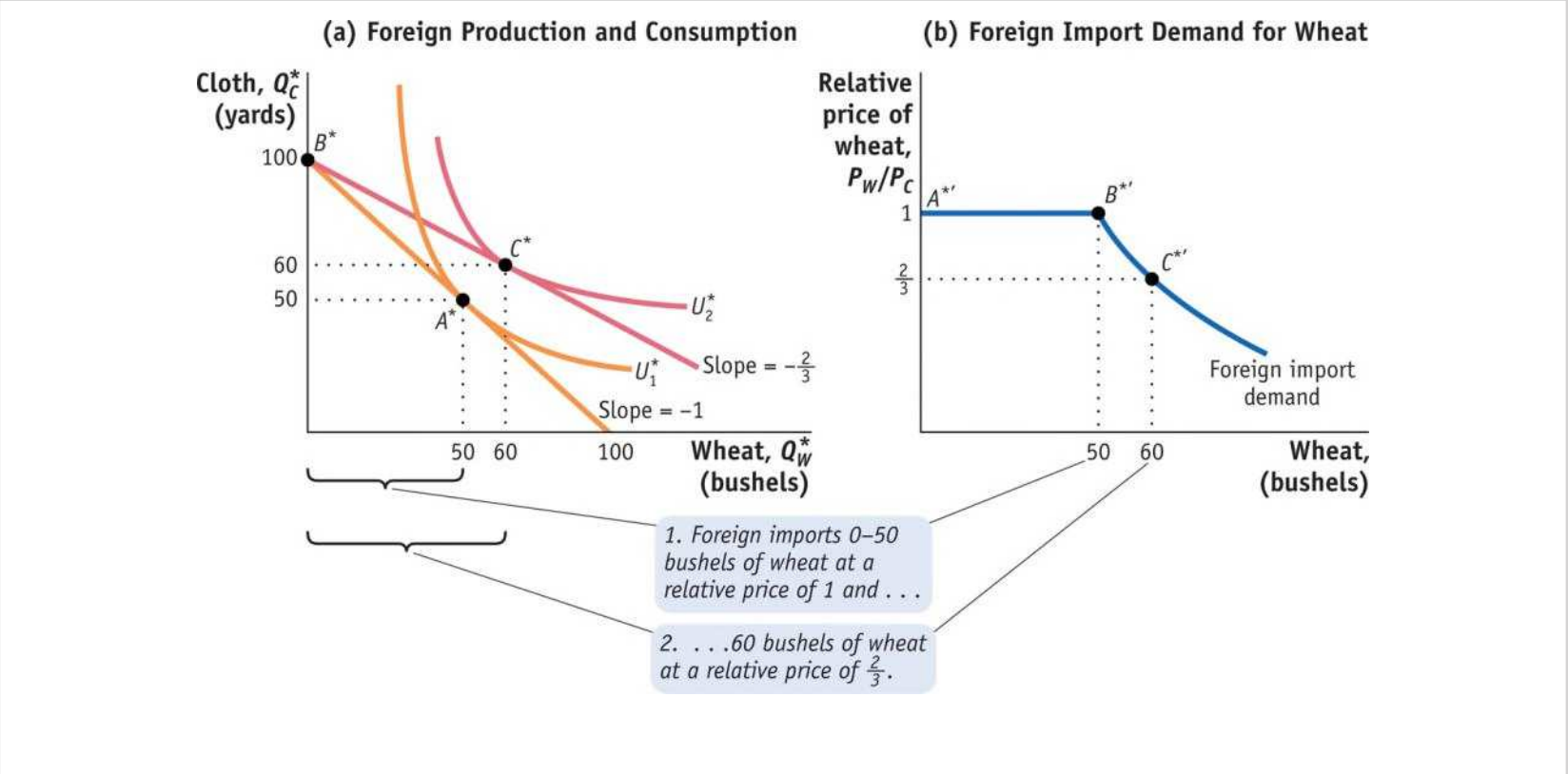
4 Solving for International Prices

Foreign Import Demand Curve

FIGURE 2-10 (2 of 2)



Foreign Import Demand (continued) 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 $^2/_3$, Foreign imports 60 bushels of wheat.

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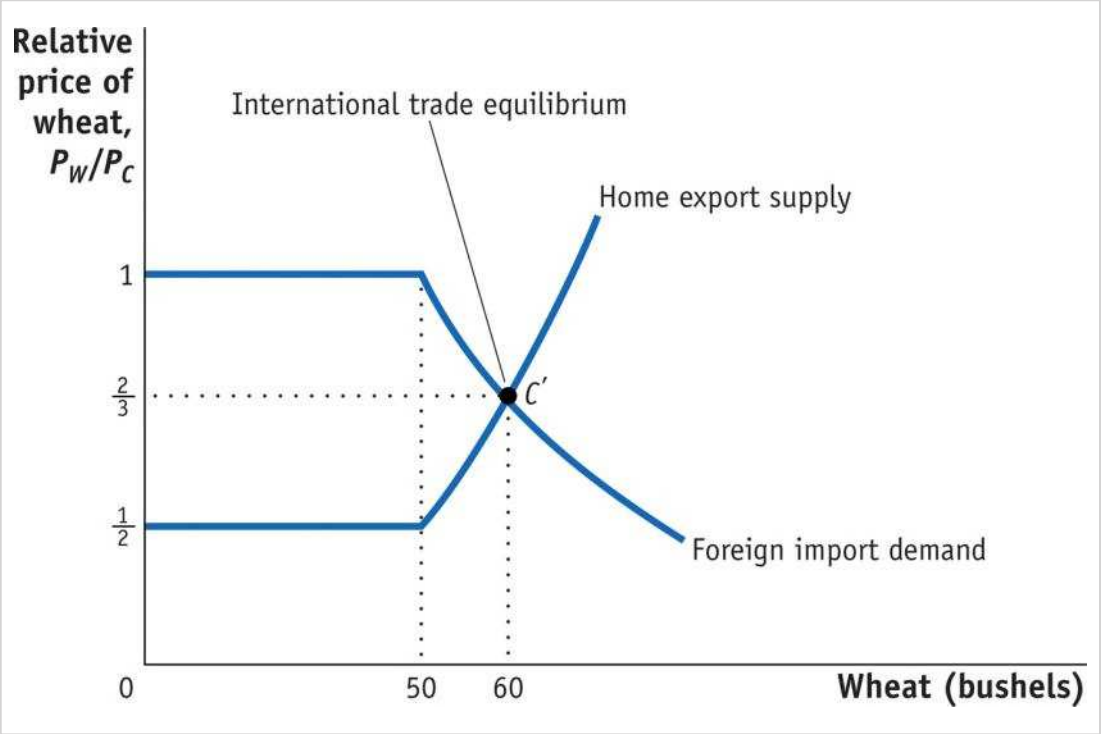
International Trade Equilibrium

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 $^2/_3$.

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International Trade Equilibrium

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.
- 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.

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Application

The Terms of Trade for Primary Commodities

Economists Raúl Prebisch and Hans Singer argued that the price of primary commodities would decline over time relative to the price of manufactured goods.

Support for Hypothesis

- As people/countries become richer, they spend a smaller share of their income on food.
- For mineral products, industrialized countries continually find substitutes in the production of manufactured products.

Evidence Against Hypothesis

- Technological progress in manufactured goods can certainly lead to a fall in the price of these goods as they become easier to produce.
- At least for oil, the cartel restricting prices has caused an increase in the terms of trade for oil-exporting countries.

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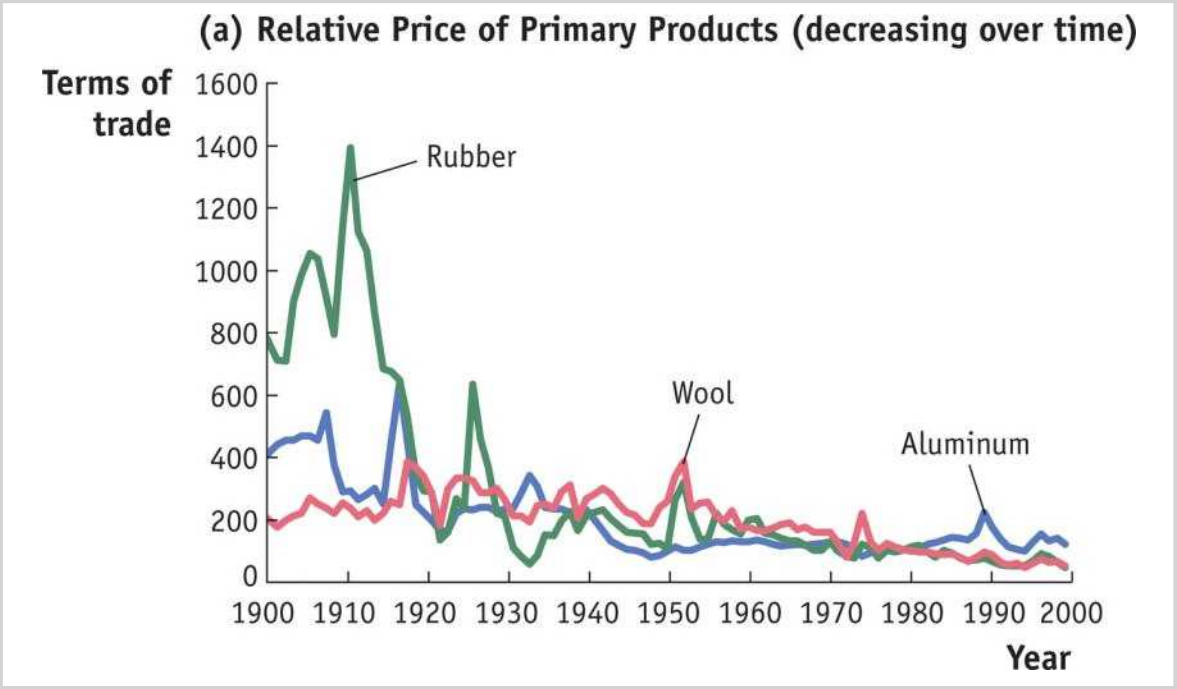
APPLICATION

The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel a)



Relative Price of Primary Commodities 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)…

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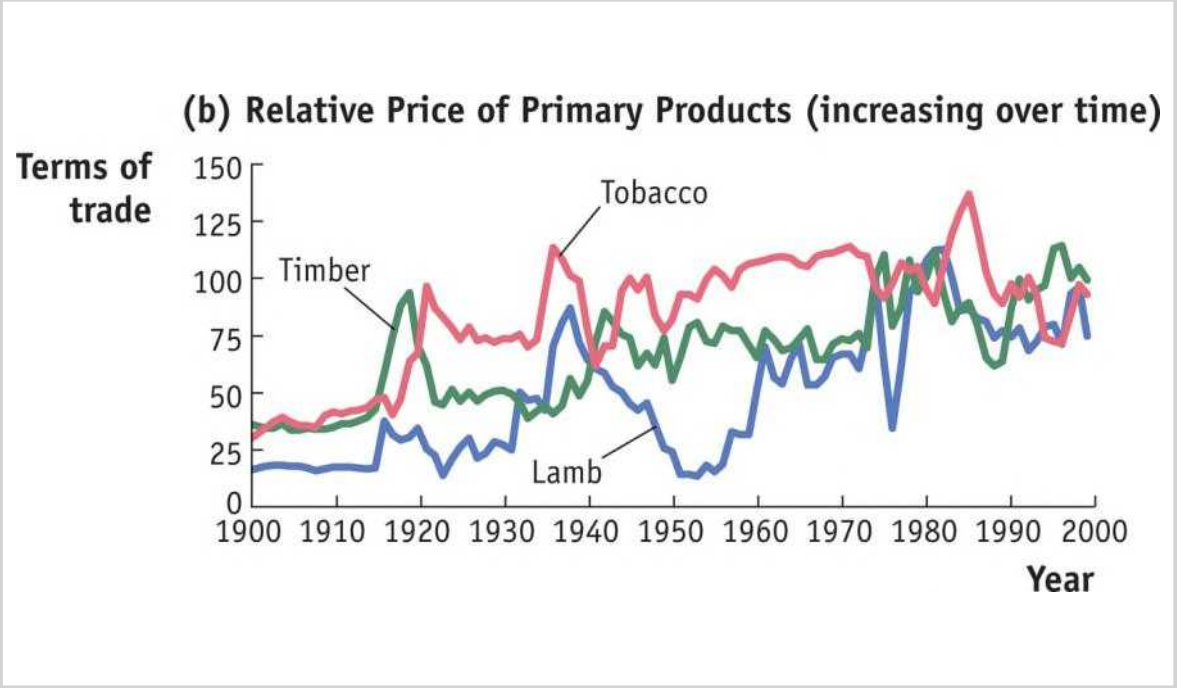
APPLICATION

The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel b)



Relative Price of Primary Commodities … whereas other commodities have had rising relative prices (panel b)…

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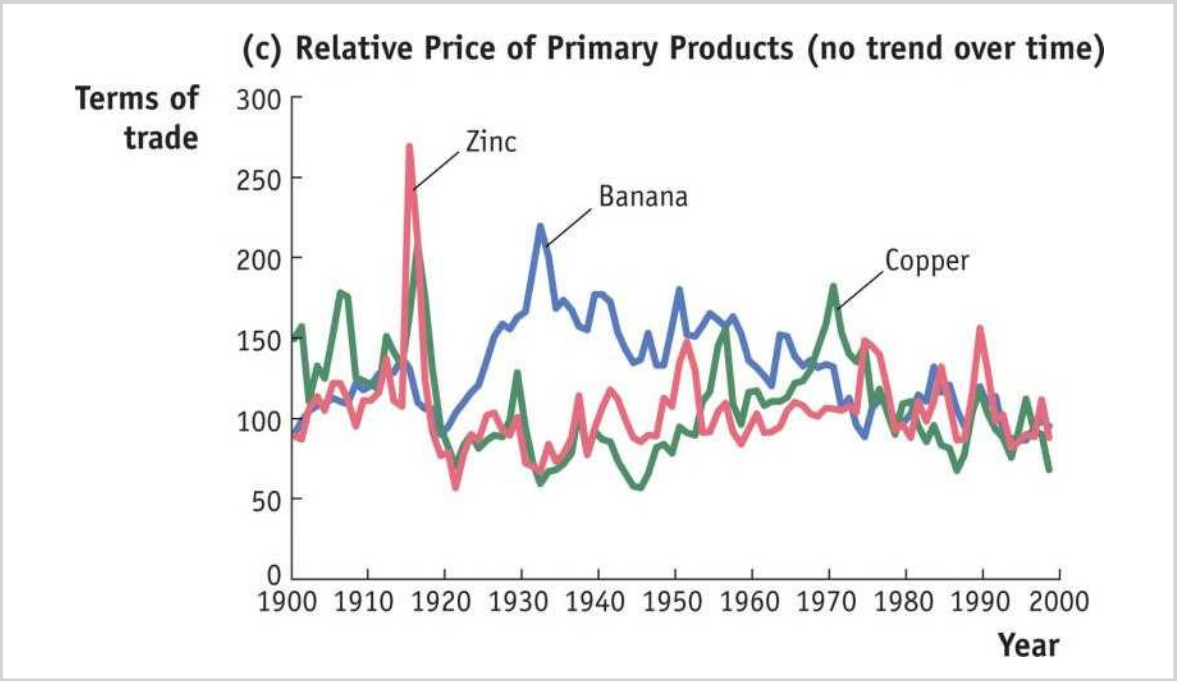
APPLICATION

The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel c)



Relative Price of Primary Commodities … Other commodity prices show no consistent trend over time (panel c).

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KEY POINTS

1. A country has comparative advantage in producing a good when the country's opportunity cost of producing the good is lower than the opportunity cost of producing the good in another country.

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KEY POINTS

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.

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KEY POINTS

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.

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KEY POINTS

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.

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KEY POINTS

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.

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KEY POINTS

6. A country's terms of trade equal 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.

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KEY TERMS

import
export
technology
resources
offshoring
proximity
Ricardian model
trade pattern
free-trade area

natural resources
labor resources
capital
factors of production
foreign direct investment
absolute advantage
comparative advantage
marginal product of labor (MPL)
production possibilities frontier (PPF)

opportunity cost
indifference curves
utility
relative price
international trade equilibrium
world price line
gains from trade
export supply curve
import demand curve
terms of trade

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