3

Gains and Losses from Trade in the Specific-Factors Model

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

Evo Morales, President of Bolivia, 2006[1]

We estimate that import competition from China, which surged after 2000, was a major force behind both recent reductions in US manufacturing employment and . . . weak overall US job growth. Our central estimates suggest job losses from rising Chinese import competition over 1999–2011 in the range of 2.0–2.4 million.

Daron Acemoglu et al., "Import Competition and the Great US Employment Sag of the 2000s," 2016[2]

Questions to Consider

1 Do you personally gain from inexpensive imported goods?

2 Besides you, who gains and who loses from trade?

3 What government policies can help firms and workers that lose from trade?

For nearly 14 years, Evo Morales was the president of Bolivia. First elected in December 2005 and taking office in January 2006, he was the first Aymara Indian elected to president in Bolivia's 180-year history. In May 2006 he nationalized the gas industry, which meant that all natural gas resources were placed under the control of the state-owned energy company. With this policy change, foreign investors lost their majority ownership claims to the gas fields, pipelines, and refineries that they had built, and they also lost a significant portion of the profits from the sales of Bolivian natural gas. This drastic step, which was criticized heavily by foreign governments, was supported by the majority of Bolivians. By nationalizing the gas industry, President Morales ensured that these profits would go to the people of Bolivia.

A new constitution in 2009 gave indigenous peoples control over natural resources in their territories. Companies from Japan and Europe made deals with the Morales government to extract this resource, but the government ensured that the gains flowed to the local population through poverty-reduction programs. Since 2009, Bolivia experienced high economic growth, averaging at least 4% per year

[1] Speech from the San Alberto field operated by Petrobras, "Bolivia Nationalizes Natural Gas Industry," *USA Today*, May 1, 2006.
[2] Daron Acemoglu, David Autor, David Dorn, Gordon H. Hanson, and Brendan Price, 2016, "Import Competition and the Great US Employment Sag of the 2000s," *Journal of Labor Economics*, 34(S1), S141–S198.

up to 2018, and millions of people—especially from indigenous rural areas—were pulled out of poverty. There was substantial migration from rural areas to cities such as El Alto, which was the site of violent protests before the election of Evo Morales but then became host to thriving small businesses owned by both men and women.[3]

According to the new constitution, any president can serve for only two terms, but the first term served by Morales occurred before the constitution in 2009, so Evo Morales was reelected twice more—in 2009 and in 2014. He wanted to continue as president and in 2016 a public referendum was held that would allow him to run for another term. The referendum was narrowly defeated. Dissatisfied with this outcome, Morales persuaded the Bolivian Supreme Court to grant him the right to run again. So in the election of October 2019, President Morales was a candidate and at first it appeared that he had won the election. But then evidence of irregularities in the voting were reported, and violent demonstrations broke out in Bolivia once again. President Morales resigned his position and fled to Mexico. In November 2019, a provisional government was set up in Bolivia, which promised to hold new elections on May 3, 2020. It remains to be seen what the future holds for the Bolivian government and for the continuation of the policies started under President Morales.

The Bolivian experience illustrates the difficulty of ensuring that all people within a country share in the gains from trade. Despite the abundant natural gas resources, along with other minerals such as silver, tin, and lithium (used to make car batteries), many of the local population remained in poverty. The difficulty of sharing these gains among Bolivia's citizenry made the export of gas a contentious issue. Although the export of natural gas clearly generated gains for the foreign-owned and state-owned companies that sold the resources, the indigenous peoples did not historically share in those gains. President Morales was able to correct that historic injustice so the indigenous peoples shared in the gains, but he did not ensure that these gains would necessarily continue through a stable transfer of power to the next president.

A key lesson from this chapter is that in most cases, opening a country to trade generates winners *and* losers. In general, the gains of those who benefit from trade exceed the losses of those who are harmed, and in this sense there are overall gains from trade. That was a lesson from the Ricardian model in the last chapter. But our argument in the last chapter that trade generates gains for *all* workers was too simple because, in the Ricardian model, labor is the only factor of production. Once we make the more realistic assumption that capital and land are also factors of production, then trade generates gains for some factors and losses for others. Our goal in this chapter is to determine who gains and who loses from trade and under what circumstances.

The concern for those who are not gaining from trade arises not only in developing countries like Bolivia but also in all countries of the world. At the beginning of the chapter we included a quote from a research study by economists in the United States. They refer to the surge in China's imports to the United States following China's entry into the World Trade Organization (WTO) in 2001. All WTO members must maintain low tariffs on imports, so these lower U.S. tariffs benefitted China.[4] According to the

[3] You can read more about this case in Simon Romero, "In Bolivia, Untapped Bounty Meets Nationalism," *New York Times*, February 3, 2009, and in Sara Shahriari, "The Booming World: Bolivia," *The Guardian*, December 20, 2012, from which this paragraph is drawn.

[4] The tariffs that President Trump has imposed against China and other countries, discussed in Chapter 1, are all exceptions to these WTO rules. In Chapter 8 we will explain why these exceptions can be made, so that under specific circumstances, WTO members can apply tariffs against other WTO members.

study, after China joined the WTO, its rising imports into the United States led to a substantial loss of jobs in U.S. import industries, so the factory owners and workers in those industries did not gain from trade. Balanced against these losses, however, we should take into account the gains for farmers, factory owners, and workers in U.S. *export* industries. An important lesson of this chapter is that while there are losses in import industries, there will be gains in export industries, and that on balance there are gains overall.

The model we use to analyze the role of international trade in determining the earnings of labor, land, and capital assumes that one industry (agriculture) uses labor and land and the other industry (manufacturing) uses labor and capital. This model is sometimes called the **specific-factors model** because land is *specific* to the agriculture sector and capital is *specific* to the manufacturing sector; labor is used in both sectors, so it is not specific to either one. The idea that land is specific to agriculture and that capital is specific to manufacturing may be true in the short run but does not really hold in the long run. In later chapters, we develop a long-run model, in which capital and other resources can be shifted from use in one industry to use in another. But for now we focus on the short-run specific-factors model, which offers many new insights about the gains from trade beyond those obtained from the Ricardian model.

1 Specific-Factors Model

We address the following question in the specific-factors model: How does trade affect the earnings of labor, land, and capital? We have already seen from our study of the Ricardian model that when a country is opened to free trade, the relative price of exports rises and the relative price of imports falls. Thus, the question of how trade affects factor earnings is really a question of how changes in *relative prices* affect the earnings of labor, land, and capital. The idea we develop in this section is that the earnings of *specific factors*, or *fixed factors* (such as capital and land), rise or fall primarily because of changes in relative prices (i.e., specific-factor earnings are the most sensitive to relative price changes) because in the short run they are "stuck" in a sector and cannot be employed in other sectors. In contrast, mobile factors (such as labor) can offset their losses somewhat by seeking employment in other industries.

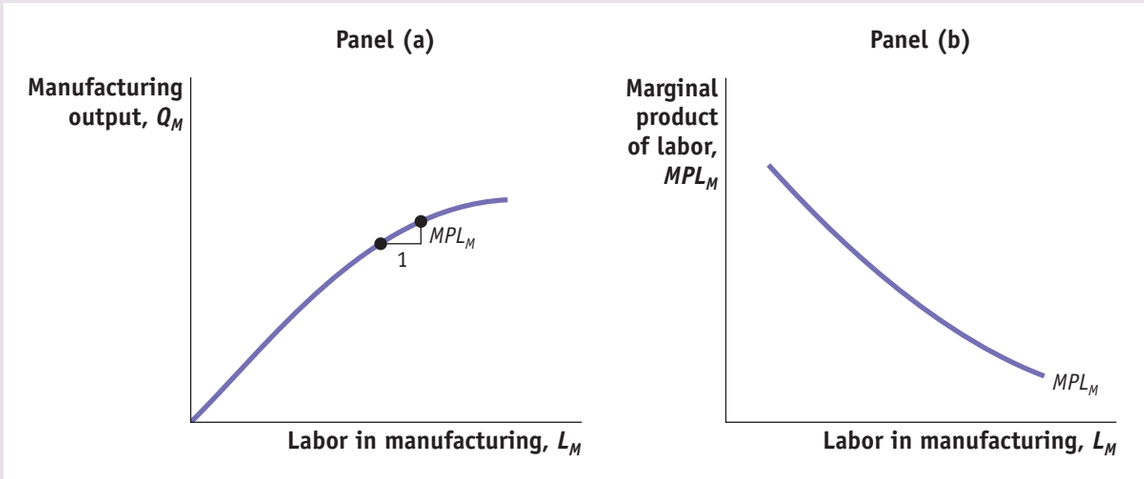
As in our study of international trade in Chapter 2, we look at two countries, called Home and Foreign. We first discuss the Home country.

The Home Country

Let us call the two industries in the specific-factors model "manufacturing" and "agriculture." Manufacturing uses labor and capital, whereas agriculture uses labor and land. In each industry, increases in the amount of labor used are subject to **diminishing returns**; that is, the marginal product of labor declines as the amount of labor used in the industry increases. Figure 3-1(a) plots output against the amount of labor used in production, and it shows diminishing returns for the manufacturing industry. As more labor is used, the output of manufacturing goes up, but it does so at a diminishing rate. The slope of the curve in Figure 3-1(a) measures the marginal product of labor, which declines as labor increases.

Figure 3-1(b) graphs MPL_M, the marginal product of labor in manufacturing, against the labor used in manufacturing L_M. This curve slopes downward because of diminishing returns. Likewise, in the agriculture sector (not drawn), the marginal

FIGURE 3-1



Panel (a) Manufacturing Output As more labor is used, manufacturing output increases, but it does so at a diminishing rate. The slope of the curve measures the marginal product of labor, which declines as the quantity of labor used in manufacturing increases.

Panel (b) Diminishing Marginal Product of Labor An increase in the amount of labor used in manufacturing lowers the marginal product of labor.

product of labor MPL_A also diminishes as the amount of labor used in agriculture L_A increases.

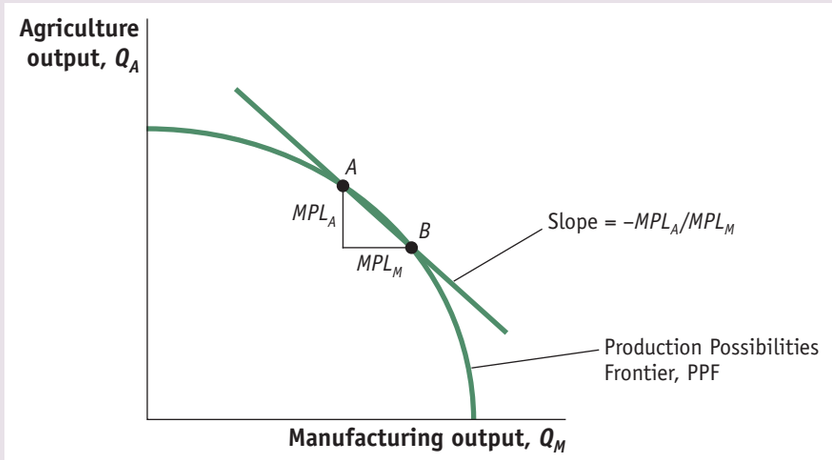
Production Possibilities Frontier Combining the output for the two industries, manufacturing and agriculture, we obtain the production possibilities frontier (PPF) for the economy (Figure 3-2). Because of the diminishing returns to labor in both sectors, the PPF is *bowed out*, or concave, with respect to the graph's origin. (You may recognize this familiar shape from your introductory economics class.)

By using the marginal products of labor in each sector, we can determine the slope of the PPF. Starting at point A in Figure 3-2, suppose that one unit of labor leaves agriculture and enters manufacturing so that the economy's new output is at point B. The drop in agricultural output is MPL_A, and the increase in manufacturing output is MPL_M. The slope of the PPF between points A and B is the negative of the ratio of marginal products, or $-MPL_A/MPL_M$. This ratio can be interpreted as the opportunity cost of producing one unit of manufacturing, the cost of one unit of manufacturing in terms of the amount of food (the agricultural good) that would need to be given up to produce it.

Opportunity Cost and Prices As in the Ricardian model, the slope of the PPF, which is the opportunity cost of manufacturing, also equals the relative price of manufacturing. To understand why this is so, recall that in competitive markets, firms hire labor up to the point at which the cost of one more worker (the wage) equals the value of one more worker in terms of output. In turn, the value of one more worker equals the amount of goods produced by that person (the marginal product of labor) times the price of the good. In manufacturing, labor will be hired to the point at which the wage W equals the price of manufacturing P_M times the marginal product of labor in manufacturing MPL_M.

$$W = P_M \cdot MPL_M$$

FIGURE 3-2



Production Possibilities Frontier
The production possibilities frontier shows the amount of agricultural and manufacturing outputs that can be produced in the economy with labor. Its slope equals $-MPL_A/MPL_M$, the ratio of the marginal products of labor in the two industries. The slope of the PPF can be interpreted as the opportunity cost of the manufacturing output—it is the amount of the agricultural good that would need to be given up to obtain one more unit of output in the manufacturing sector.

Similarly, in agriculture, labor will be hired to the point at which the wage W equals the price of agriculture P_A times the marginal product of labor in agriculture MPL_A.

$$W = P_A \cdot MPL_A$$

Because we are assuming that labor is free to move between sectors, the wages in these two equations must be equal. If the wages were not the same in both sectors, labor would move to the sector with the higher wage. This movement would continue until the increase in the amount of labor in the high-wage sector drove down the wage, and the decrease in the amount of labor in the low-wage sector drove up the wage, until the wages were equal. By setting the two wage equations equal, we obtain $P_M \cdot MPL_M = P_A \cdot MPL_A$, and by rearranging terms, we get

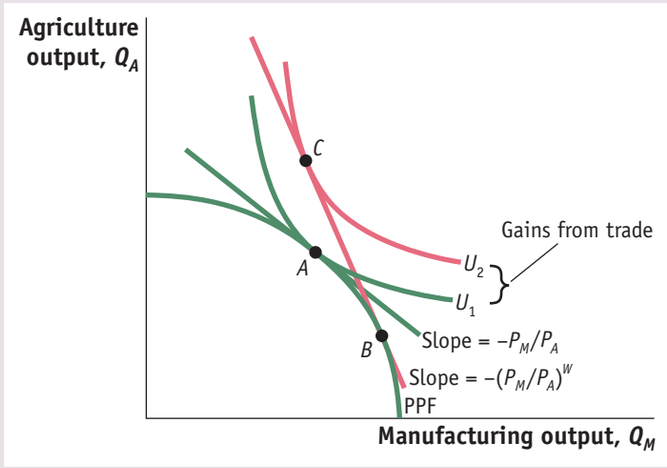
$$(P_M/P_A) = (MPL_A/MPL_M)$$

This equation shows that the relative price of manufacturing (P_M/P_A) equals the opportunity cost of manufacturing (MPL_A/MPL_M), the slope of the production possibilities frontier. These relative prices also reflect the value that Home's consumers put on manufacturing versus food. In the absence of international trade, the equilibrium for the Home economy is at point A in Figure 3-3, where the relative price of manufacturing (P_M/P_A) equals the slope of the PPF as well as the slope of the indifference curve for a representative consumer with utility of U_1. The intuition for the no-trade equilibrium is exactly the same as for the Ricardian model in Chapter 2: equilibrium occurs at the tangency of the PPF and the consumer's indifference curve. This point on the PPF corresponds to the highest possible level of utility for the consumer.

The Foreign Country

In this chapter, we do not discuss the Foreign country in any detail. Instead, we simply assume that the no-trade relative price of manufacturing in Foreign (P_M^*/P_A^*) differs from the no-trade price (P_M/P_A) in Home. There are several reasons why these prices can differ. In the previous chapter, we showed how differences in productivities across countries cause the no-trade relative prices to differ across countries. That is the key assumption, or starting point, of the Ricardian model. Another reason for relative prices to differ, which we have not yet investigated, is that the amounts of labor,

FIGURE 3-3



Increase in the Relative Price of Manufactures In the absence of international trade, the economy produces and consumes at point *A*. The relative price of manufactures, P_M/P_A, is the slope of the line tangent to the PPF and indifference curve, U_1, at point *A*. With international trade, the economy is able to produce at point *B* and consume at point *C*. The world relative price of manufactures, $(P_M/P_A)^W$, is the slope of the line *BC*. The rise in utility from U_1 to U_2 is a measure of the gains from trade for the economy.

capital, or land found in the two countries are different. (That will be the key assumption of the Heckscher–Ohlin model, which we discuss in the next chapter.)

For now, we will not explain why the no-trade relative prices differ across countries but will take it for granted that this is not unusual. For the sake of focusing on one case, let us assume that the Home no-trade relative price of manufacturing is *lower* than the Foreign relative price, $(P_M/P_A) < (P_M^*/P_A^*)$. This assumption means that Home can produce manufactured goods relatively more cheaply than Foreign, or, equivalently, that Home has a comparative advantage in manufacturing.

Overall Gains from Trade

Starting at the no-trade equilibrium point *A* in Figure 3-3, suppose that Home opens up to international trade with Foreign. Once trade is opened, we expect that the world equilibrium relative price—that is, the relative price in *all* countries $(P_M/P_A)^W$—will lie between the no-trade relative prices in the two countries, so

$$(P_M/P_A) < (P_M/P_A)^W < (P_M^*/P_A^*)$$

This equation shows us that when Home opens to trade, the relative price of manufacturing will *rise*, from (P_M/P_A) to $(P_M/P_A)^W$; conversely, for Foreign, the relative price of manufacturing will *fall*, from (P_M^*/P_A^*) to $(P_M/P_A)^W$. With trade, the world relative price $(P_M/P_A)^W$ is represented by a line that is tangent to Home's PPF, line *BC* in Figure 3-3. The increase in the Home relative price of manufactured goods is shown by the steeper slope of the world relative price line as compared with the Home no-trade price line (through point *A*).

What is the effect of this increase in (P_M/P_A) in Home? The higher relative price of the manufactured good in Home attracts more workers into that sector, which now produces at point *B* rather than *A*. As before, production takes place at the point along the Home PPF tangent to the relative price line, where equality of wages across industries is attained. The country can then export manufactured goods and import agricultural products along the international price line *BC*, and it reaches its highest level of utility, U_2, at point *C*. The difference in utility between U_2 and U_1 is a measure of the country's overall gains from trade. (These overall gains would be zero if the relative prices with trade equaled the no-trade relative prices, but they can never be negative—a country can never be made worse off by opening to trade.)

Notice that the good whose relative price goes up (manufacturing, for Home) is exported and the good whose relative price goes down (agriculture, for Home) is imported. By exporting manufactured goods at a higher price and importing food at a lower price, Home is better off than it was in the absence of trade. To measure the gains from trade, economists rely on the price increases for exports and the price decreases for imports to determine how much extra consumption a country can afford. The following application considers the magnitude of the overall gains from trade in historical cases in which the gains have been measured.

APPLICATION

How Large Are the Gains from Trade?

How large are the overall gains from trade? There are a few historical examples of countries that have moved from **autarky** (i.e., no trade) to free trade, or vice versa, quickly enough that we can use the years before and after this shift to estimate the gains from trade.

One such episode in the United States occurred between December 1807 and March 1809, when the U.S. Congress imposed a nearly complete halt to international trade at the request of President Thomas Jefferson. A complete stop to all trade is called a **trade embargo**. The United States imposed its embargo because Britain was at war with Napoleon, and Britain wanted to prevent ships from arriving in France that might be carrying supplies or munitions. As a result, Britain patrolled the eastern coast of the United States and seized U.S. ships that were bound across the Atlantic. To safeguard its own ships and possibly inflict economic losses on Britain, the United States declared a trade embargo for 14 months from 1807 to 1809. The embargo was not complete, however; the United States still traded with some countries, such as Canada and Mexico, that didn't have to be reached by ship.

As you might expect, U.S. trade fell dramatically during this period. Exports (such as cotton, flour, tobacco, and rice) fell from about $49 million in 1807 to $9 million in 1809. The drop in the value of exports reflects both a drop in the quantity exported and a drop in the price of exports. Recall that in Chapter 2 we defined the terms of trade of a country as the price of its export goods divided by the price of its import goods, so a drop in the price of U.S. exports is a fall in its terms of trade, which is a loss for the United States. According to one study, the cost of the trade embargo to the United States was about 5% of gross domestic product (GDP). That is, U.S. GDP was 5% lower than it would have been without the trade embargo. The cost of the embargo was offset somewhat because trade was not completely eliminated and because some U.S. producers were able to shift their efforts to producing goods (such as cloth and glass) that had previously been imported. Thus, we can take 5% of GDP as a lower estimate of what the gains from trade for the United States would have been relative to a situation with no trade.

Another historical case was Japan's rapid opening to the world economy in 1854, after 200 years of self-imposed autarky. In this case, military action by Commodore Matthew Perry of the United States forced Japan to open up its borders so that the United States could establish commercial ties. When trade was opened, the prices of Japanese exports to the United States (such as silk and tea) increased, and the prices of U.S. imports (such as woolens) decreased. These price movements were a terms-of-trade gain for Japan. According to one estimate, Japan's gains from trade after its opening were 4% to 5% of GDP.[5] The gains were not one-sided, however; Japan's trading partners—such as the United States—also gained from being able to trade in the newly opened markets.

There are no recent examples of industrial countries suddenly opening or closing to trade. Instead, we can rely on the theory of international trade to infer what the gains from trade are. In Figure 3-3, the extent to which the consumption point *C* is lifted off

[5] Daniel M. Bernhofen and John C. Brown, March 2005, "Estimating the Comparative Advantage Gains from Trade," *American Economic Review*, 95(1), 208–225.

TABLE 3-1

Gains from Trade, 2007 This table shows the ratio of total trade to GDP for selected countries, calculated as (Imports + Exports)/2, and two estimates of the gains from trade. The first estimate is the gains from trade from imported final goods used by consumers. The second estimate reflects imported intermediate inputs that are used by firms, and it includes services, which are treated as a nontraded sector. Countries with the highest ratios of trade to GDP tend to have the highest gains from trade.

Country	Trade/GDP (%)	Gains from Trade (%)	Adjusted Gains (%)
Malaysia	116%	74%	219%
Hungary	81	87	166
Thailand	75	51	89
Switzerland	65	135	111
Austria	56	104	96
Denmark	54	79	75
Sweden	50	58	55
Germany	44	46	40
Norway	38	63	51
South Africa	37	31	42
Canada	33	54	44
China	33	13	30
United Kingdom	30	45	32
Indonesia	29	25	36
Italy	29	33	38
Mexico	29	45	34
Spain	29	52	53
Greece	28	73	122
France	28	39	35
Turkey	26	38	41
Russian Federation	26	25	35
Venezuela	25	28	41
India	25	14	21
Argentina	23	28	32
Pakistan	18	37	62
Japan	16	26	21
United States	15	19	14
Brazil	14	10	10
Average	38	48	59

Note: Trade is calculated as (Imports + Exports)/2, including merchandise goods and services, with data for the year 2008.

Data from: World Development Indicators, The World Bank, and Ralph Ossa, 2015, "Why Trade Matters After All," Journal of International Economics*, 97(2), 266–277.*

the production possibilities frontier will depend on how much trade there is. If there is very little trade, then point *C* will be close to the autarky consumption point *A*, and the gains from trade are small. If there is a lot of trade, then the consumption point *C* will differ from the production point *B*, and so *C* is lifted off the PPF by more and the gains from trade are large. This means that we can use the amount of imports or exports that a country has (measured as a share of GDP) to infer its gains from trade. In addition, because countries often import goods that are different from those they produce at home, calculating the gains from trade requires knowing the value that consumers place on the imported goods as compared to the domestic substitutes for these imports.

With this approach, the gains from trade for a number of countries in the world are shown in Table 3-1 for the year 2007.[6] These estimates are based on trade in merchandise

[6] This is the most recent year for which these estimates of the gains from trade are available.

goods only (that is, manufacturing, agriculture, and mining) and do not include services trade. We show the ratio of trade to GDP in the first column, which is the highest for Malaysia and the lowest for Brazil. Then we provide two estimates of the gains from trade, both measured as a percentage of GDP. The first estimate is the gains from trade from imported *final goods* that are used by consumers. The second, adjusted estimate of the gains also includes imported *intermediate inputs* that are used by firms, as well as services, which are treated as a nontraded sector.

Generally, countries with the highest ratios of trade to GDP tend to have the highest gains from trade. Malaysia, for example, has the highest ratio of trade to GDP (116%) and among the highest estimates of the gains from trade (between 74% and 219%). Brazil, on the other hand, has the lowest ratio of trade to GDP (14%) and the lowest estimate of the gains from trade (10%). We see that the United States is just above Brazil and that Japan is just above the United States: both those countries have very large economies, and as we discussed in Chapter 1, very large economies tend to have lower ratios of trade to GDP because we do not count the *internal* trade that happens within a country. For the same reason, the estimates of the gains from international trade are lower for large economies. Still, the average size of the gains from trade is quite large: between 48% and 59%, as shown at the bottom of Table 3-1.

2 Earnings of Labor

Because there are overall gains from trade, *someone* in the economy must be better off, but not *everyone* is better off. The goal of this chapter is to explore how a change in relative prices, such as that shown in Figure 3-3, feeds back into the earnings of workers, landowners, and capital owners. We begin our study of the specific-factors model by looking at what happens to the wages earned by labor when there is an increase in the relative price of manufactures.

Determination of Wages

To determine wages, it is convenient to take the marginal product of labor in manufacturing (MPL_M), which was shown in Figure 3-1(b), and the marginal product of labor in agriculture (MPL_A), and put them in one diagram.

First, we add the amount of labor used in manufacturing L_M and the amount used in agriculture L_A to give us the total amount of labor in the economy $\overline{L}$:

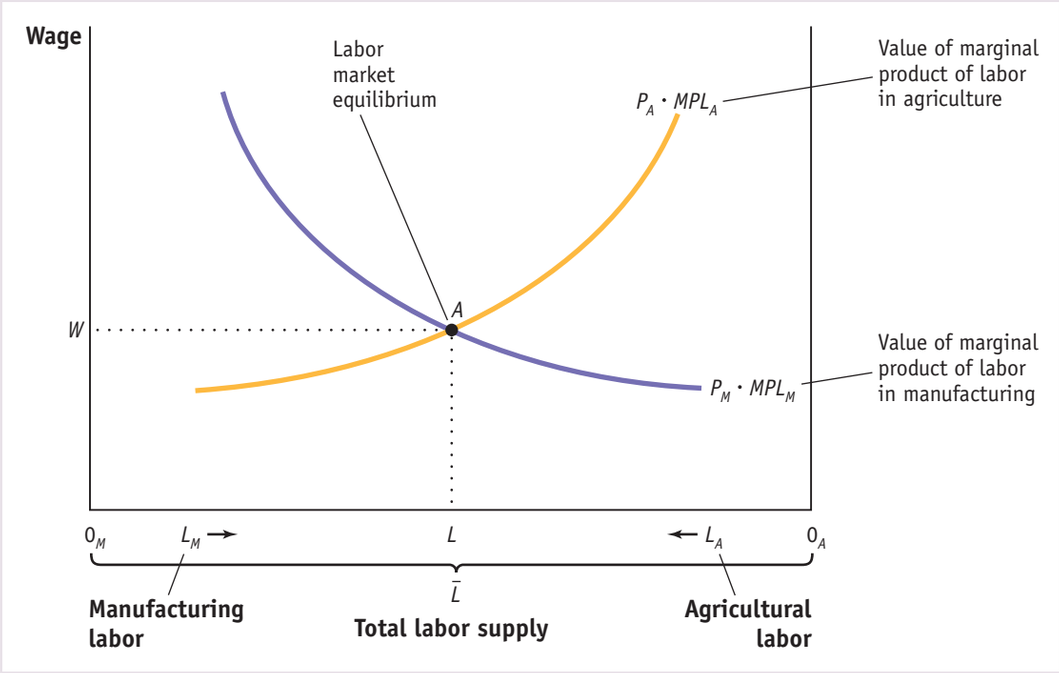
$$L_M + L_A = \overline{L}$$

Figure 3-4 shows the total amount of labor $\overline{L}$ on the horizontal axis. The amount of labor used in manufacturing L_M is measured from left (0_M) to right, while the amount of labor used in agriculture L_A is measured from right (0_A) to left. Each point on the horizontal axis indicates how much labor is used in manufacturing (measured from left to right) and how much labor is used in agriculture (measured from right to left). For example, point L indicates that $0_M L$ units of labor are used in manufacturing and $0_A L$ units of labor are used in agriculture, which adds up to $\overline{L}$ units of labor in total.

The second step in determining wages is to multiply the marginal product of labor in each sector by the price of the good in that sector (P_M or P_A). As we discussed earlier, in competitive markets, firms will hire labor up to the point at which the cost of one more worker (the wage) equals the value of one worker in production, which is the marginal product of labor times the price of the good. In each industry, then, labor will be hired until

$$W = P_M \cdot MPL_M \text{ in manufacturing}$$
$$W = P_A \cdot MPL_A \text{ in agriculture}$$

FIGURE 3-4



Allocation of Labor Between Manufacturing and Agriculture The amount of labor used in manufacturing is measured from left to right along the horizontal axis, and the amount of labor used in agriculture is measured from right to left. Labor market equilibrium is at point *A*. At the equilibrium wage of *W*, manufacturing uses $0_M L$ units of labor and agriculture uses $0_A L$ units.

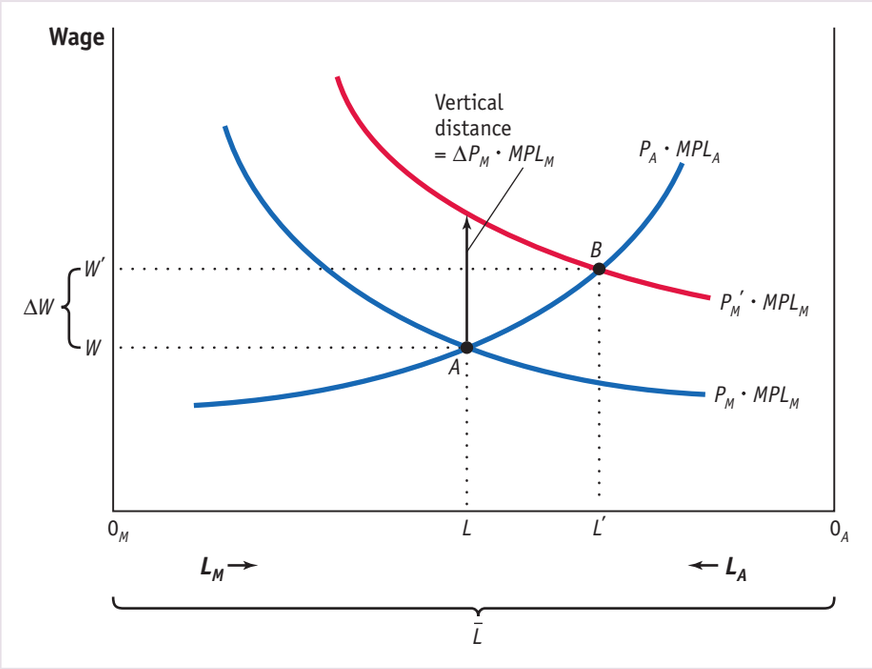
In Figure 3-4, we draw the graph of $P_M \cdot MPL_M$ as downward sloping. This curve is basically the same as the marginal product of labor MPL_M curve in Figure 3-1(b), except that it is now multiplied by the price of the manufactured good. When we draw the graph of $P_A \cdot MPL_A$ for agriculture, however, it slopes upward. This is because we are measuring the labor used in agriculture L_A from *right to left* in the diagram: the marginal product of labor in agriculture falls as the amount of labor increases (moving from right to left).

Equilibrium Wage The equilibrium wage is found at point *A*, the intersection of the curves $P_M \cdot MPL_M$ and $P_A \cdot MPL_A$ in Figure 3-4. At this point, $0_M L$ units of labor are used in manufacturing, and firms in that industry are willing to pay the wage $W = P_M \cdot MPL_M$. In addition, $0_A L$ units of labor are used in agriculture, and farmers are willing to pay the wage $W = P_A \cdot MPL_A$. Because wages are equal in the two sectors, there is no reason for labor to move, and the labor market is in equilibrium.

Change in Relative Price of Manufactures

Now that we have shown how the wage is determined in the specific-factors model, we want to ask how the wage *changes* in response to an increase in the relative price of manufactures. That is, as the relative price of manufactures rises (shown in Figure 3-3), and the economy shifts from its no-trade equilibrium at point *A* to its trade equilibrium with production and consumption at points *B* and *C*, what is the effect on the earnings of each factor of production? In particular, what are the changes

FIGURE 3-5



Increase in the Price of Manufactured Goods With an increase in the price of the manufactured good, the curve $P_M \cdot MPL_M$ shifts up to $P_M' \cdot MPL_M$ and the equilibrium shifts from point *A* to point *B*. The amount of labor used in manufacturing rises from $0_M L$ to $0_M L'$, and the amount of labor used in agriculture falls from $0_A L$ to $0_A L'$ The wage increases from *W* to *W′*, but this increase is less than the upward shift $\Delta P_M \cdot MPL_M$.

in the wage, and in the earnings of capital owners in manufacturing and landowners in agriculture?

Effect on the Wage An increase in the relative price of manufacturing P_M/P_A can occur due to either an increase in P_M or a decrease in P_A. Both these price movements will have the same effect on the **real wage,** that is, on the amount of manufactures and food that a worker can afford to buy. For convenience, let us suppose that the price of manufacturing P_M rises, while the price of agriculture P_A does not change.

When P_M rises, the curve $P_M \cdot MPL_M$ shifts up to $P_M' \cdot MPL_M$, as shown in Figure 3-5. The vertical rise in this curve is exactly $\Delta P_M \cdot MPL_M$, as illustrated in the diagram. (We use the symbol Δ, delta, to stand for the *change* in a variable.) The new intersection of the two curves occurs at point *B*, where the wage is *W′* and the allocation of labor between the two sectors is identified by point *L′*. The equilibrium wage has risen from *W* to *W′*, the amount of labor used in the manufacturing sector has increased from $0_M L$ to $0_M L'$, and the amount of labor used in agriculture has fallen from $0_A L$ to $0_A L'$.

Effect on Real Wages The fact that the wage has risen does not really tell us whether workers are better off or worse off in terms of the amount of food and manufactured goods they can buy. To determine this, we have to take into account any change in the prices of these goods. For instance, the amount of food that a worker can afford to buy with their hourly wage is W/P_A.[7] Because *W* has increased from *W* to *W′* and we have assumed that P_A has not changed, workers can afford to buy more food. In other words, the real wage has increased in terms of food.

[7] For example, suppose that you earn \$12 per hour, and your favorite snack costs \$3. Then you could afford to buy \$12/\$3 = 4 of these snacks after working for one hour.

The amount of the manufactured good that a worker can buy is measured by W/P_M. While W has increased, P_M has also increased, so at first glance we do not know whether W/P_M has increased or decreased. However, Figure 3-5 can help us figure this out. Notice that as we've drawn Figure 3-5, the increase in the wage from W to W' is less than the vertical increase $\Delta P_M \cdot MPL_M$ that occurred in the $P_M \cdot MPL_M$ curve. We can write this condition as

$$\Delta W < \Delta P_M \cdot MPL_M$$

To see how W/P_M has changed, divide both sides of this equation by the initial wage W (which equals $P_M \cdot MPL_M$) to obtain

$$\frac{\Delta W}{W} < \frac{\Delta P_M \cdot MPL_M}{P_M \cdot MPL_M} = \frac{\Delta P_M}{P_M}$$

where the final ratio is obtained because we canceled out MPL_M in both the numerator and denominator of the middle ratio. The term $\Delta W/W$ in this equation is the *percentage change in wages.* For example, suppose the initial wage is \$8 per hour and it rises to \$10 per hour. Then $\Delta W/W$ = \$2/\$8 = 0.25, which is a 25% increase in the wage. Similarly, the term $\Delta P_M/P_M$ is the *percentage change in the price of manufactured goods.* When $\Delta W/W < \Delta P_M/P_M$, then the percentage increase in the wage is *less than* the percentage increase in the price of the manufactured good. This inequality means that the amount of the manufactured good that can be purchased with the wage has fallen, so the *real wage in terms of the manufactured good* W/P_M has decreased.[8]

Overall Impact on Labor We have now determined that as a result of our assumption of an increase in the relative price of manufactured goods, the *real wage in terms of food has increased and the real wage in terms of the manufactured good has decreased*. In this case, we assumed that the increase in relative price was caused by an increase in the price of manufactures with a constant price of agriculture. Notice, though, that if we had assumed a constant price of manufactures and a decrease in the price of agriculture (taken together, an increase in the relative price of manufactures), then we would have arrived at the same effects on the real wage in terms of both products.

Is labor better off or worse off after the price increase? We cannot tell. People who spend most of their income on manufactured goods are worse off because they can buy fewer manufactured goods, but those who spend most of their income on food are better off because more food is affordable. Who spends most of their income on food? It is well established that poor individuals spend a greater share of their income than rich individuals on food: this finding is called **Engel's Law**. Thus, if food prices are falling due to trade, then poorer people will be gaining from the price fall more than rich people. We discuss whether this finding holds when looking across many countries in **Side Bar: Do Poor or Rich Consumers Gain the Most from Trade?** The bottom line is that in the specific-factors model, the increase in the price of the manufactured good has an ambiguous effect on the real wage and therefore an ambiguous effect on the well-being of workers, depending on which goods they consume the most.

The conclusion that we cannot tell whether workers are better off or worse off from the opening of trade in the specific-factors model might seem wishy-washy to you, but it is important for several reasons. First, this result is different from what we found in the Ricardian model of Chapter 2, in which the real wage increases with the opening of trade so that workers are always unambiguously better off than they

[8] For example, suppose that the manufactured good is memory sticks, which initially cost \$9 and then rise in price to \$12. The increase in the price of memory sticks is \$3, and so the percentage increase in their price is $\Delta P_M/P_M$ = \$3/\$9 = 0.33 = 33%. Suppose also that the wage has increased from \$10 to \$12 per hour, or 20%, which is less than the percentage increase in the price of a memory stick. Using the initial prices, by working one hour, you could afford to buy W/P_M = \$10/\$9 = 1.1, or *more than* one memory stick. Using the new prices, by working one hour, you can afford to buy W/P_M = \$12/\$12 = 1, or exactly one memory stick. So, your real wage measured in terms of memory sticks has gone down.

SIDE BAR

Do Poor or Rich Consumers Gain the Most from Trade?

Trade lowers the relative price of imported goods in each country and raises the relative price of exported goods. It follows that consumers who spend a greater portion of their income on imported goods will tend to gain, and consumers who spend a greater portion of their income on exported goods will tend to lose. The gains for each individual also depend on their sources of income. In the idealized model of this chapter, all workers earn the same wage and therefore have the same income. In reality, individuals earn different wages because of their differing levels of education and skills, and they also have earnings from owning capital and land, so they can have very different incomes.

It follows that there are two channels by which changes in prices due to international trade affect individuals: through the change in the prices of goods that they buy, and through the change in the income that they earn. Let us call the first channel the *spending channel* and the second channel the *earnings channel*. How do these channels affect poor versus rich individuals around the world?

Let us start with the spending channel. If the prices of food tend to fall due to international trade, then that will benefit poor consumers the most, because they spend a greater share of their income on food. This conclusion is supported by a detailed study of international trade and consumption across many countries.[9] Food and other necessities that are demanded more by low-income individuals are imported into many countries, so these poor individuals gain the most from purchasing those imports. It follows that the spending channel tends to benefit poor consumers the most.

There are exceptions to this rule. Not all countries are importers of food. The United States, for example, exports many agricultural goods and has roughly balanced trade in food. The share of food imports within the budgets of U.S. households falls slightly as income rises, but not by as much. Furthermore, imported luxury goods are demanded more by rich households in the United States: those goods include cars—and richer individuals prefer foreign brands—and consumer electronics like computers. Looking across all goods, the effects of falling import shares in food and rising import shares in luxury goods tend to cancel out, and so there is no systematic relationship between the budget share devoted to imports overall and consumer's income. This means that the spending channel does not favor the poor versus the rich in the United States.[10]

What about the earnings channel? How do changing prices affect the incomes of poor versus rich individuals? As we will discuss in Chapter 7, international trade has tended to raise the incomes of higher-skilled individuals in the United States as compared to those with fewer skills. Thus, the earnings channel tends to favor richer individuals in the United States. Does this conclusion hold in the rest of the world? We explore this challenging question in later chapters.

[9] Pablo Fajgelbaum and Amit Khandelwal, 2016, "Measuring the Unequal Gains from Trade," *Quarterly Journal of Economics*, 131, 1113–1180.

[10] Kirill Borusyak and Xavier Jaravel, 2018, "The Distributional Effects of Trade: Theory and Evidence from the United States," Working Paper, University College London and London School of Economics.

are in the absence of trade.[11] In the specific-factors model, that is no longer the case; the opening of trade and the shift in relative prices raise the real wage in terms of one good but lower it in terms of the other good. Second, our results for the specific-factors model serve as a warning against making unqualified statements about the effect of trade on workers, such as "Trade is bad for workers" or "Trade is good for workers." Even in the specific-factors model, which is simplified by considering only two industries and not allowing capital or land to move between them, we have found that the effects of opening trade on the real wage are complicated. In reality, the effect of trade on real wages is more complex still.

Unemployment in the Specific-Factors Model We have ignored one significant, realistic feature in the specific-factors model: unemployment. You may often see news stories about workers who are laid off because of import competition and who then face a period of unemployment. Despite this outcome, most economists do not believe that trade necessarily harms workers overall. It is true that we have ignored unemployment in the specific-factors model: the labor employed in manufacturing L_M plus the labor employed in agriculture L_A always sums to the total labor supply $\overline{L}$, which means that there is no unemployment. One of the reasons we ignore unemployment in this model is that it is usually treated as a macroeconomic phenomenon, caused by business cycles, and it is hard to combine business cycle models with international trade models to isolate the effects of trade on workers. But the other, simpler

[11] The only situation in which workers do not gain from trade in the Ricardian model is if Home is very large, as discussed in Problem 11 of Chapter 2, such that the international relative price equals the no-trade relative price. In that case, Home workers are no better off from international trade but also no worse off.

reason is that even when people are laid off because of import competition, many of them find new jobs within a reasonable period, and sometimes they find jobs with *higher* wages, as shown in the next application. Therefore, even if we take into account spells of unemployment, once we recognize that workers can find new jobs—possibly in export industries that are expanding—then we still cannot conclude that trade is necessarily good or bad for workers.

In the two applications that follow, we look at some evidence from the United States on employment in the manufacturing sector, as well as on the amount of time it takes to find new jobs and on the wages earned. We also investigate the **"China shock,"** the impact on the U.S. labor market of China joining the WTO in 2001.

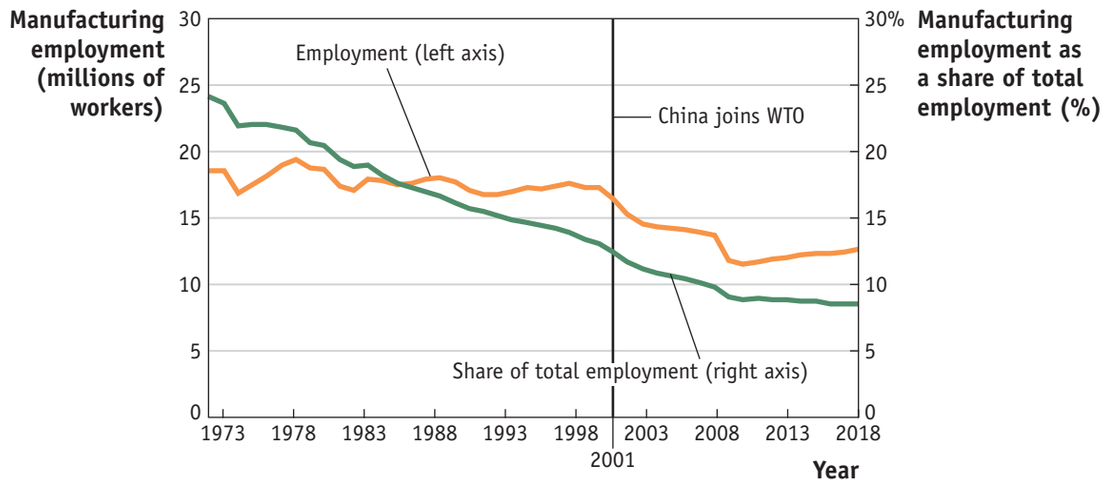
APPLICATION

Manufacturing and Services in the United States: Employment and Wages Across Sectors

Although the specific-factors model emphasizes manufacturing and agriculture, the amount of labor devoted to agriculture in most industrialized countries is small. A larger sector in industrialized countries is that of **services**, which includes wholesale and retail trade, finance, law, education, information technology, software engineering, consulting, and medical and government services. In the United States and most industrial countries, the service sector is larger than the manufacturing sector and much larger than the agriculture sector.

In Figure 3-6, we show employment in the manufacturing sector of the United States, both in terms of the number of workers employed in it and as a percentage of total employment in the economy. Using either measure, employment in manufacturing has been falling over time; given zero or negative employment growth in the agriculture sector, this indicates that the service sector has been growing. As we mentioned at the beginning of the chapter, China joined the WTO in 2001, and the employment decline in Figure 3-6 appears to accelerate after 2001, as we discuss in the next Application.

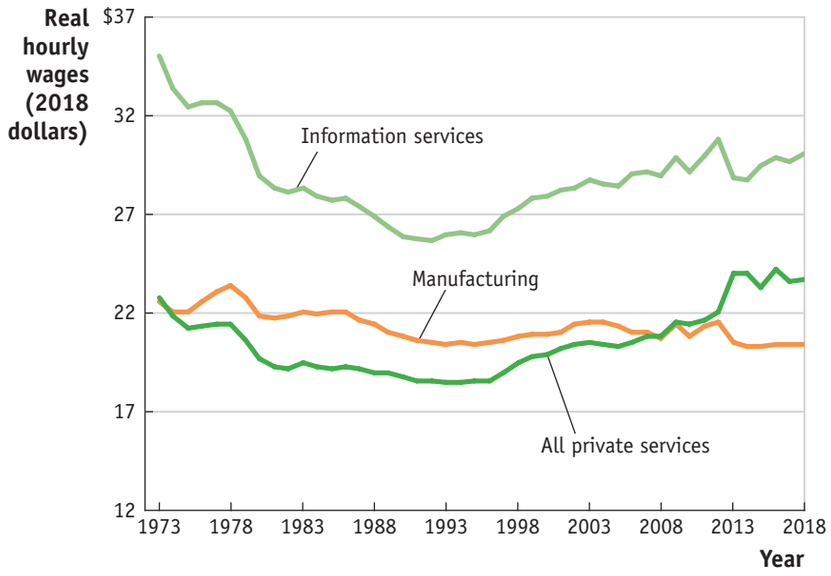
FIGURE 3-6



U.S. Manufacturing Sector Employment, 1973–2018 Employment in the U.S. manufacturing sector is shown on the left axis, and the share of manufacturing employment in total U.S. employment is shown on the right axis. Both manufacturing employment and its share in total employment have been falling over time, indicating that the service sector has been growing. The decline in manufacturing employment accelerated after China joined the WTO in 2001.

Data from: U.S. Department of Labor, Bureau of Labor Statistics.

FIGURE 3-7



Real Hourly Earnings of Production Workers, 1973–2018 This chart shows the real wages (in constant 2018 dollars) earned by production workers in U.S. manufacturing, in all private services, and in information services (a subset of all private services). Although wages were slightly higher in manufacturing than in all private services from 1973 through 2007, all private service wages have been higher since 2008. This change is due in part to the effect of wages in the information service industry, which are substantially higher than those in manufacturing. Real wages for production workers in manufacturing have tended to fall since about 1986, whereas real wages in the service sector fell until about 1996 but have been rising since then. Real wages in information services have been growing since about 1993.

Data from: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 3-7 shows the real wages earned by production, or blue-collar, workers in manufacturing, in all private services, and in information services (a subset of private services).[12] Although wages were slightly higher in manufacturing than in private services from 1973 through 2007, all private service wages have been higher since 2008. This change is due in part to the effect of wages in the *information service* industry, which are substantially higher than those in manufacturing. For example, average hourly earnings in all private services were $23.66 per hour in 2018 and lower—$20.44 per hour—in manufacturing overall. But in information services, average wages were much higher—$30.07 per hour.

In both manufacturing and services, many workers are *displaced* or laid off each year and need to look for other jobs. In the three years from January 2015 to December 2017, for example, about 479,000 workers were displaced in manufacturing and 2.2 million in all service industries, as shown in Table 3-2. Of those laid off in manufacturing, 65% were reemployed by January 2018. Slightly more than one-half (53%) of these workers earned less in their new jobs, and slightly less than one-half (47%) earned the same or more. For services, 69% of workers were reemployed by January 2018, with the same percentages earning less or more in their new jobs. The total economy also includes workers in agriculture, mining, and government positions, and two-thirds (66%) of all displaced workers were reemployed by January 2018, nearly evenly split between those who earned less and those who earned the same or more in their new jobs.

There are four lessons that we can take away from this comparison of employment and wages in manufacturing and services. First, wages differ across different sectors in the economy, so our theoretical assumption that wages are the same in agriculture and

[12] The real wages shown in Figure 3-7 are measured relative to consumer prices in 2018 and represent the average hourly earnings for *production* workers, those workers involved in the assembly of services or products. Production workers are sometimes called "blue-collar" workers and typically earn hourly wages. The other category of workers, *nonproduction* workers, includes managers and all those who work at a desk. They are sometimes called "white-collar" workers and typically earn annual salaries instead of hourly wages.

TABLE 3-2

Job Losses in Manufacturing and Service Industries, 2015–2017 This table shows the number of displaced workers in manufacturing and service industries from 2015 to 2017. A total of 65% of the manufacturing workers displaced from 2015 to 2017 were reemployed by January 2018, with 53% earning less in their new jobs in manufacturing and 47% earning the same or more. The numbers are nearly the same in service industries, with 69% of workers finding work by January 2018.

		PERCENTAGES		
Industry	Total Displaced Workers (thousands) Jan 2015–Dec 2017	Workers Reemployed by Jan 2018	Of the Workers Reemployed:	
			Earn Less in New Job	Earn Same or More in New Job
Total	2,981	66%	51%	49%
Manufacturing industries	479	65%	53%	47%
Service industries	2,239	69%	53%	47%

Data from: U.S. Bureau of Labor Statistics.

manufacturing is a simplification. Second, many workers are displaced each year and must find jobs elsewhere. Some of these workers may be laid off because of competition from imports, but there are other reasons, too—for instance, popular products go out of fashion, firms reorganize as computers and other technological advances become available, and businesses change locations. Third, about two-thirds of displaced workers find a new job within two or three years but not necessarily at the same wage. Typically, older workers (aged 45 to 64 years) experience earnings losses when shifting between jobs, whereas younger workers (aged 25 to 44 years) are often able to find a new job with the same or higher wages. Finally, when we measure wages in real terms by adjusting for inflation in the price of consumer goods, we see that real wages for all production workers fell in most years between 1979 and 1995 (we examine the reasons for that fall in later chapters). The real wages for production workers in manufacturing have risen only slightly and then fallen again since then, while the real wages for workers in services have risen by much more, so that workers in services now have higher earnings than those in manufacturing on average (especially so for workers in information services).

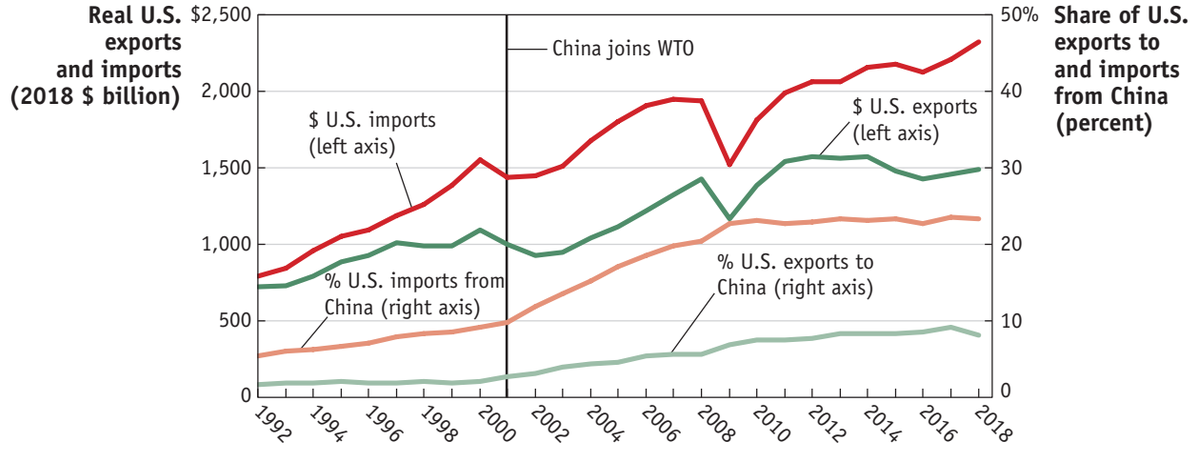
APPLICATION

The "China Shock" and Employment in the United States

In the specific-factors model, we assumed that the workers leaving one industry could be absorbed freely into the other. In reality, when there is a very large change in prices, it can take more than 10 years for enough jobs to be created in export industries to balance the losses in import industries. This application examines what has happened since China joined the WTO.

After China joined the WTO in 2001, it could expect to receive the same low tariffs in the United States and other countries as those enjoyed by other WTO members. The higher import tariffs that President Trump applied against China in 2018–2019 are an exception to this rule, as we discuss in Chapter 8. Still, from 2001 to 2017 China received the low WTO tariffs in the United States, and those lower tariffs encouraged investment by existing and new Chinese firms in the production of goods for the U.S. market. As a result, U.S. imports from China grew rapidly after 2001, as is shown in Figure 3-8.

FIGURE 3-8



Real U.S. Imports and Exports and the China Share, 1992–2018
Real values (in 2018 dollars) of U.S. nonpetroleum imports (the red line) and exports (the green line) to the world are shown on the left axis. The share of U.S. imports coming from China (the orange line) and the share of U.S. exports going to China (the light green line) are shown on the right axis. Real imports roughly tripled over this period and real exports roughly doubled. The share of U.S. imports coming from China grew noticeably faster after China's entry to the WTO in 2001, and it more than doubled, from 10% that year to 23% in 2009 through 2018. In comparison, the share of U.S. exports going to China is fairly small; it grew from 3% in 2001 to 8% in 2018.
Data from: U.S. Department of the Census, Foreign Trade Division.

During the period 1992–2018, the real value of U.S. nonpetroleum imports from the world roughly tripled. A substantial amount of that growth was accounted for by increased imports from China. In Figure 3-8, we see that the share of U.S. imports from China grew noticeably faster after its entry to the WTO in 2001. That share more than doubled from 10% in 2001 to 23% in 2009, and it remained at that high level through 2018.

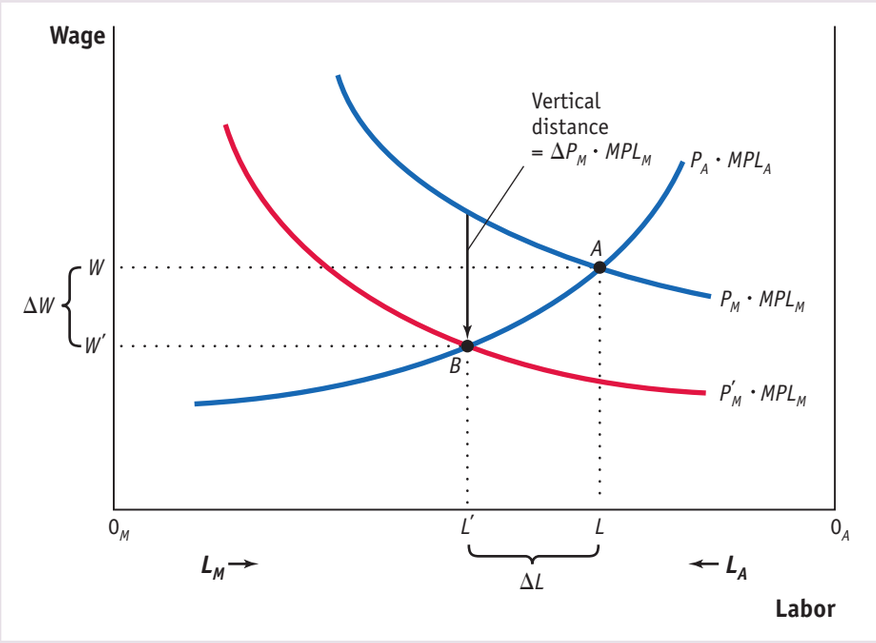
China is less important as a destination for U.S. exports than as a source of imports. Despite the fairly small percentage of U.S. exports going to China, the real value of U.S. nonpetroleum exports to the world still grew rapidly, more than doubling from 1992 to 2018.

Several research studies have examined the impact of growing U.S. imports from China on employment in manufacturing industries. The large increase in the share of U.S. imports coming from China and its impact on employment in manufacturing are called the "China shock."[13] These studies have found that 2 million jobs or more were lost in U.S. manufacturing industries, as summarized in the quotation at the beginning of the chapter.

We can interpret these job losses using the specific-factors model. Instead of an increase in the price of manufactured goods, as we looked at earlier in the chapter, we now suppose that inexpensive imports from China led to a decrease in the price of manufactured goods. In Figure 3-9, we start at equilibrium A and then experience a fall in the manufacturing price. When P_M falls, the curve $P_M \cdot MPL_M$ shifts down to $P'_M \cdot MPL_M$,

[13] David Autor, David Dorn, and Gordon H. Hanson, 2013, "The China Syndrome: Local Labor Markets Effects of Import Competition in the United States," *American Economic Review*, 103(6), 2121–2168; Daron Acemoglu, David Autor, David Dorn, Gordon H. Hanson, and Brendan Price, 2016, "Import Competition and the Great US Employment Sag of the 2000s," *Journal of Labor Economics*, 34(S1), S141–S198.

FIGURE 3-9



Decrease in the Price of Manufactured Goods With a decrease in the price of manufactured goods, the curve $P_M \cdot MPL_M$ shifts down to $P'_M \cdot MPL_M$ and the equilibrium shifts from point *A* to point *B*. The amount of labor used in manufacturing falls from $0_M L$ to $0_M L'$, and the amount of labor used in agriculture rises from $0_A L$ to $0_A L'$. So the amount of labor ΔL is transferred from manufacturing to agriculture. The wage falls by the amount by the amount ΔW, from W to W'.

as shown in Figure 3-9. The vertical fall in this curve is exactly $\Delta P_M \cdot MPL_M$. The new intersection of the two curves occurs at point *B*, where the wage is W' and the allocation of labor between the two sectors is identified by point L'. The equilibrium wage has fallen from W to W', the amount of labor used in the manufacturing sector has fallen from $0_M L$ to $0_M L'$, and the amount of labor used in agriculture has increased from $0_A L$ to $0_A L'$.

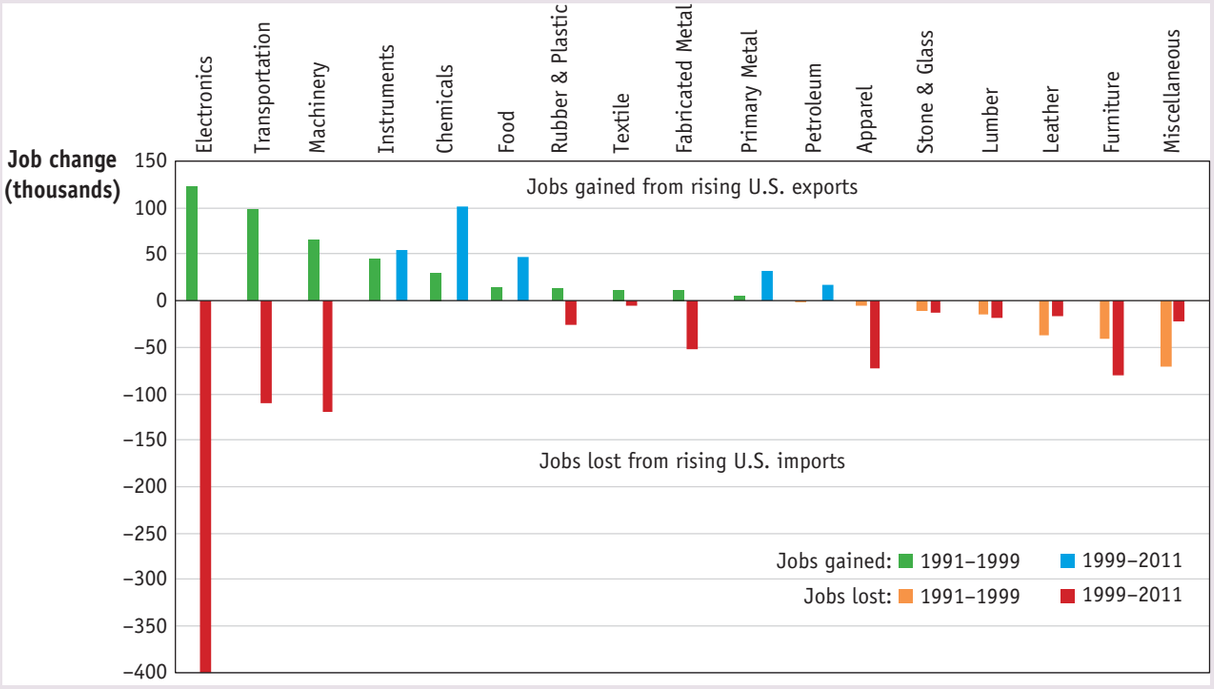
We label the total shift in labor from the manufacturing sectors to the agriculture sector by the amount ΔL. From research studies, about 2 million workers were shifted out of the U.S. manufacturing sector due to rising imports from China. In Figure 3-9, this amount of labor ΔL is quickly absorbed into "agriculture," which we should think of in reality as any industry in manufacturing or agriculture that is exported by the United States. To compare our diagram to the actual U.S. economy, we need to ask whether or not these workers really find employment in export industries.

To answer this question, we start by looking at U.S. job gains and losses in various manufacturing industries during the decade before China joined the WTO (1991–1999).[14] Figure 3-10 shows the estimated job gains in the United States due to rising exports to the world (in green), and the estimated job losses due to rising U.S. imports from the world (in orange), over 1991–1999. In this period, U.S. industries such as electronics, transportation, and machinery experienced the greatest job gains, while the largest job losses were in leather, furniture, and miscellaneous industries. The number of industries that gained jobs due to rising U.S. exports exceeded the number of industries that experienced job losses from rising imports.

After China joined the WTO in 2001, however, the picture changed completely. Figure 3-10 also shows the estimated job gains due to rising U.S. exports to the world (in blue), and the estimated job losses due to rising U.S. imports from the world (in red), over 1999–2011.[15] Many industries such as electronics, transportation, and machinery

[14] We have omitted the job changes in certain industries (like paper, printing, and tobacco) because these changes were small.
[15] The employment data are not available to study the job gains and losses for the year 2001, when China joined the WTO.

FIGURE 3-10



Job Gains and Job Losses in U.S. Manufacturing Industries, 1991–1999 and 1999–2011 For the period 1991–1999, estimated job gains due to rising U.S. exports are shown in green, and the estimated job losses due to rising U.S. imports are shown in orange. In this period, U.S. industries such as electronics, transportation, and machinery experienced the greatest job gains. For the period 1999–2011, estimated job gains due to rising U.S. exports are shown in blue, and the estimated job losses due to rising U.S. imports are shown in red. In this period, industries such as electronics, transportation, and machinery (which had experienced the greatest job gains over 1991–1999) now faced import competition, especially from China, and experienced job losses. Only a small number of industries such as chemicals, instruments, and food experienced job gains.

Data from: Robert C. Feenstra, Hong Ma, and Yuan Xu, 2019, "US Exports and Employment," Journal of International Economics, 120, 46–58.

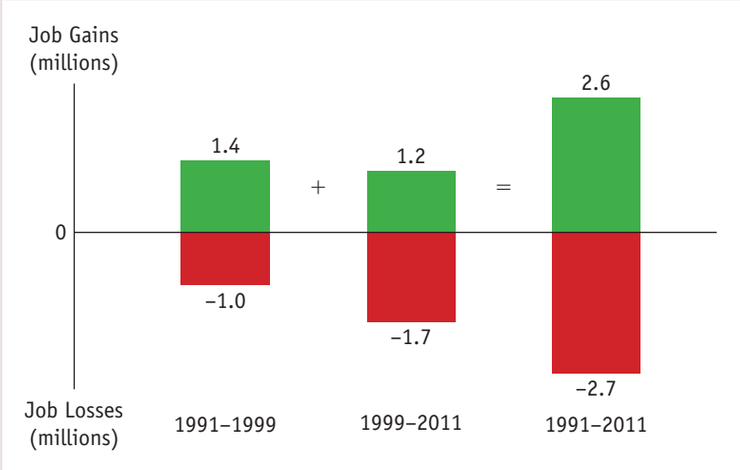
that had experienced the greatest job gains over 1991–1999 now faced import competition, especially from China, and, as a result, experienced job losses in 1999–2011. Only a small number of industries such as instruments, chemicals, and food experienced job gains.

Figure 3-11 summarizes the results from the first period, 1991–1999, the second period, 1999–2011, and the entire two decades, 1991–2011. For each period we add up the job gains from rising exports and the job losses from rising imports.[16] As a result of rising imports, there were about 1 million jobs lost before China joined the WTO, in 1991–1999. That number grew to about 1.7 million jobs lost in the decade 1999–2011, after China joined the WTO in 2001. Over both periods, the total number of jobs lost was 2.7 million. Those job losses reflect the impact of imports from *all countries*, but imports from China, which grew particularly rapidly, account for the majority of the job losses.

Balancing out these job losses were jobs created by rising exports: about 1.4 million jobs in 1991–1999, and 1.2 million jobs in 1999–2011. Over both periods, the total number of jobs created was 2.6 million. The U.S. exports to China explain only a small part of these job gains, which are primarily due to U.S. exports to the rest of world.

[16] The job gains and losses shown in Figure 3-11 include additional jobs gained and lost outside of manufacturing. That is why the totals in Figure 3-11 exceed what we get if we add up the job gains and losses from Figure 3-10.

FIGURE 3-11



Total Job Gains and Job Losses in the U.S. Manufacturing Sector, 1991–2011 The estimated job gains due to rising exports are shown in green, and the estimated job losses due to rising U.S. imports are shown in red. These job gains and losses are the total for all manufacturing industries for the periods 1991–1999, 1999–2011, and 1991–2011. Job losses exceed job gains for the period 1999–2011 after China joined the WTO, but the losses are nearly balanced with the gains for the two decades 1991–2011.

Data from: Robert C. Feenstra, Hong Ma, and Yuan Xu, 2019, "US Exports and Employment," Journal of International Economics, 120, 46–58.

Taking the difference between our findings for imports and exports, we see that in the decade *before* China joined the WTO (1991–1999), job gains exceeded job losses by 400,000 jobs. In the period *after* China joined the WTO (1999–2011), job losses exceeded job gains by 500,000 jobs. We conclude that in the long run, over the two decades 1991–2011, job losses exceeded job gains by only 100,000, so that these gains and losses are close to being balanced. In the specific-factors model, we assumed that the workers leaving one industry could be absorbed freely into the other. In reality, we see that with a very large change in prices (as occurred with the "China shock"), it takes more than one decade for enough jobs to be created in export industries to balance the losses in import industries.

3 Earnings of Capital and Land

Let us now return to the specific-factors model. We have found that with the opening of trade and an increase in the relative price of manufactures, there are overall gains for the country, but labor does not necessarily gain. What about the gains to the other factors of production, either the capital used in manufacturing or the land used in agriculture? Capital and land are the two specific factors of production that cannot shift between the two industries; let us now look at the effect of the increase in the relative price of manufactures on the earnings of these specific factors.

Determining the Payments to Capital and Land

In each industry, capital and land earn what is left over from sales revenue after paying labor. Labor (L_M and L_A) earns the wage W, so total payments to labor in manufacturing are $W \cdot L_M$ and in agriculture are $W \cdot L_A$. By subtracting the payments to labor from the sales revenue earned in each industry, we end up with the payments to capital and to land. If Q_M is the output in manufacturing and Q_A is the output in agriculture, the revenue earned in each industry is $P_M \cdot Q_M$ and $P_A \cdot Q_A$, and the payments to capital and to land are

$$\text{Payments to capital} = P_M \cdot Q_M - W \cdot L_M$$
$$\text{Payments to land} = P_A \cdot Q_A - W \cdot L_A$$

It will be useful to take these payments one step further and break them down into the earnings of each unit of capital and land. To do so, we need to know the quantity of capital and land. We denote the quantity of land used in agriculture as T acres and the quantity of capital (number of machines) used in manufacturing as K. Thus, the earnings of one unit of capital (a machine, for instance), which we call R_K, and the earnings of an acre of land, which we call R_T, are calculated as

$$R_K = \frac{\text{Payments to capital}}{K} = \frac{P_M \cdot Q_M - W \cdot L_M}{K}$$

$$R_T = \frac{\text{Payments to land}}{T} = \frac{P_A \cdot Q_A - W \cdot L_A}{T}$$

Economists call R_K the **rental on capital** and R_T the **rental on land**. The use of the term "rental" does not mean that the factory owners or farmers rent their machines or land from someone else, although they could. Instead, the rental on machines and land reflects what these factors of production earn during a period when they are used in manufacturing and agriculture. Alternatively, the rental is the amount these factors *could* earn if they were rented to someone else over that same time.

There is a second way to calculate the rentals, which will look similar to the formula we have used for wages. In each industry, wages reflect the marginal product of labor multiplied by the price of the good, $W = P_M \cdot MPL_M = P_A \cdot MPL_A$. Similarly, capital and land rentals can be calculated as

$$R_K = P_M \cdot MPK_M \text{ and } R_T = P_A \cdot MPT_A$$

where MPK_M is the marginal product of capital in manufacturing, and MPT_A is the marginal product of land in agriculture. These marginal product formulas give the same values for the rentals as first calculating the payments to capital and land, as we just did, and then dividing by the quantity of capital and land. We will use both approaches to obtain rental values, depending on which is easiest.

Change in the Real Rental on Capital Now that we understand how the rentals on capital and land are determined, we can look at what happens to them when the price of the manufactured good P_M rises, holding constant the price in agriculture P_A. From Figure 3-5, we know that the wage rises throughout the economy and that labor shifts from agriculture into manufacturing. As more labor is used in manufacturing, the marginal product of capital rises because each machine has more labor to work it. In addition, as labor leaves agriculture, the marginal product of land falls because each acre of land has fewer laborers to work it. The general conclusion is that *an increase in the quantity of labor used in an industry will raise the marginal product of the factor specific to that industry, and a decrease in labor will lower the marginal product of the specific factor.* This outcome does not contradict the law of diminishing returns, which states that an increase in labor will lower the marginal product *of labor* because now we are talking about how a change in labor affects the marginal product of *another factor*.

Using the preceding formulas for the rentals, we can summarize the results so far with

$$P_M \uparrow \Rightarrow \left\{ \begin{array}{l} L_M \uparrow, \text{ so that } MPK_M = R_K/P_M \uparrow \\ L_A \downarrow, \text{ so that } MPK_A = R_T/P_A \downarrow \end{array} \right\}$$

That is, the increase in the marginal product of capital in manufacturing means that R_K/P_M also increases. Because R_K is the rental for capital, R_K/P_M is the amount of the manufactured good that can be purchased with this rent. Thus, the fact that R_K/P_M increases means that the real rental on capital in terms of the manufactured good has gone up. For the increase in the real rental on capital to occur even though the price

of the manufactured good has also gone up, the percentage increase in R_K must be greater than the percentage increase in P_M.[17]

The amount of food that can be purchased by capital owners is R_K/P_A. Because R_K has increased, and P_A is fixed, R_K/P_A must also increase; in other words, the real rental on capital in terms of food has also gone up. Because capital owners can afford to buy more of both goods, they are clearly better off when the price of the manufactured good rises. Unlike labor, whose real wage increased in terms of one good but fell in terms of the other, capital owners clearly gain from the rise in the relative price of manufactured goods.

Change in the Real Rental on Land Let us now consider what happens to the landowners. With labor leaving agriculture, the marginal product of each acre falls, so R_T/P_A also falls. Because R_T is the rental on land, R_T/P_A is the amount of food that can be purchased with this rent. The fact that R_T/P_A falls means that the real rental on land in terms of food has gone down, so landowners cannot afford to buy as much food. Because the price of food is unchanged while the price of the manufactured good has gone up, landowners will not be able to afford to buy as much of the manufactured good either. Thus, landowners are clearly worse off from the rise in the price of the manufactured good because they can afford to buy less of both goods.

Summary The real earnings of capital owners and landowners move in opposite directions, an outcome that illustrates a general conclusion: *an increase in the relative price of an industry's output will increase the real rental earned by the factor specific to that industry but will decrease the real rental of factors specific to other industries*. This conclusion means that the specific factors used in export industries will generally gain as trade is opened and the relative price of exports rises, but the specific factors used in import industries will generally lose as trade is opened and the relative price of imports falls.

Numerical Example

We have come a long way in our study of the specific-factors model and conclude by presenting a numerical example of how an increase in the relative price of manufactures affects the earnings of labor, capital, and land. This example uses convenient numbers to review the results we have obtained so far. Suppose that the manufacturing industry has the following payments to labor and capital:

$$\begin{aligned} \textit{Manufacturing:}\ \text{Sales revenue} &= P_M \cdot Q_M = \$100 \\ \text{Payments to labor} &= W \cdot L_M = \$60 \\ \text{Payments to capital} &= R_K \cdot K = \$40 \end{aligned}$$

Notice that 60% of sales revenue in manufacturing goes to labor, and 40% goes to capital.

In agriculture, suppose that the payments to labor and land are as follows:

$$\begin{aligned} \textit{Agriculture:}\ \text{Sales revenue} &= P_A \cdot Q_A = \$100 \\ \text{Payments to labor} &= W \cdot L_A = \$50 \\ \text{Payments to capital} &= R_T \cdot T = \$50 \end{aligned}$$

In the agriculture industry, we assume that land and labor each earn 50% of the sales revenue.

An increase in the relative price of manufactures P_M/P_A can be caused by an increase in P_M or a decrease in P_A. To be specific, suppose that the price of manufactures P_M rises by 10%, whereas the price of agriculture P_A does not change at all. We have

[17] For example, if the price of manufactured goods rises by 6% and the rental on capital rises by 10%, then owners of capital can afford to buy 4% more of the manufactured good.

found in our earlier discussion that $\Delta W/W$, the percentage change in the wage, will be between the percentage change in these two industry prices. So let us suppose that $\Delta W/W$ is 5%. We summarize these output and factor price changes as follows:

Manufacturing: Percentage increase in price = $\Delta P_M/P_M = 10\%$
Agriculture: Percentage increase in price = $\Delta P_A/P_A = 0\%$
Both industries: Percentage increase in the wage = $\Delta W/W = 5\%$

Notice that the increase in the wage applies in both industries because wages are always equalized across sectors.

Change in the Rental on Capital Our goal is to use the preceding data for manufacturing and agriculture to compute the change in the rental on capital and the change in the rental on land. Let's start with the equation for the rental on capital, which was computed by subtracting wage payments from sales revenue and then dividing by the amount of capital:

$$R_K = \frac{\text{Payments to capital}}{K} = \frac{P_M \cdot Q_M - W \cdot L_M}{K}$$

If the price of manufactured goods rises by $\Delta P_M > 0$, holding constant the price in agriculture, then the change in the rental is

$$\Delta R_K = \frac{\Delta P_M \cdot Q_M - \Delta W \cdot L_M}{K}$$

We want to rewrite this equation using percentage changes, like $\Delta P_M/P_M$, $\Delta W/W$, and $\Delta R_K/R_K$. To achieve this, divide both sides by R_K and rewrite the equation as

$$\frac{\Delta R_K}{R_K} = \frac{(\Delta P_M/P_M) \cdot P_M \cdot Q_M - (\Delta W/W) \cdot W \cdot L_M}{R_K \cdot K}$$

You can cancel terms in this equation to check that it is the same as before.

The term $\Delta P_M/P_M$ in this equation is the percentage change in the price of manufacturing, whereas $\Delta W/W$ is the percentage change in the wage. Given this information, along with the preceding data on the payments to labor, capital, and sales revenue, we can compute the percentage change in the rental on capital:

$$\frac{\Delta R_K}{R_K} = \frac{(10\% \cdot 100 - 5\% \cdot 60)}{40} = 17.5\%$$

We see that the percentage increase in the rental on capital, 17.5%, *exceeds* the percentage increase in the relative price of manufacturing, 10% (so $\Delta R_K/R_K > \Delta P_M/P_M > 0$). This outcome holds no matter what numbers are used in the preceding formula, provided that the percentage increase in the wage is less than the percentage increase in the price of the manufactured good (as proved in Figure 3-5).

Change in the Rental on Land We can use the same approach to examine the change in the rental on land. Continuing to assume that the price of the manufactured good rises while the price in agriculture stays the same ($\Delta P_A = 0$), the change in the land rental is

$$\Delta R_T = \frac{0 \cdot Q_A - \Delta W \cdot L_A}{T}$$

Because the wage is increasing $\Delta W > 0$, it follows immediately that the *rental on land is falling*, $\Delta R_T < 0$. The percentage amount by which it falls can be calculated by rewriting the above equation as

$$\frac{\Delta R_T}{R_T} = -\frac{\Delta W}{W}\left(\frac{W \cdot L_A}{R_T \cdot T}\right)$$

Using these earlier data for agriculture in this formula, we get

$$\frac{\Delta R_T}{R_T} = -5\%\left(\frac{50}{50}\right) = -5\%$$

In this case, the land rent falls by the same percentage amount that the wage increases. This equality occurs because we assumed that labor and land receive the same share of sales revenue in agriculture (50% each). If labor receives a higher share of revenue than land, then the rent on land will fall even more; if it receives a lower share, then the rent on land won't fall as much.

General Equation for the Change in Factor Prices By summarizing our results in a single equation, we can see how all the changes in factor and industry prices are related. Under the assumption that the price of the manufactured good increased but the price of the agricultural good did not change, we have shown the following:

$$\underbrace{\Delta R_T/R_T}_{\substack{\text{Real rental}\\ \text{on land falls}}} < 0 < \underbrace{\Delta W/W}_{\substack{\text{Change in the real}\\ \text{wage is ambiguous}}} < \Delta P_M / P_M < \underbrace{\Delta R_K/R_K}_{\substack{\text{Real rental}\\ \text{on capital rises}}}, \text{ for an increase in } P_M$$

In other words, wages rise but not as much as the percentage increase in the price of the manufactured good; the rental on capital (which is specific to the manufacturing sector) rises by more than the manufacturing price, so capital owners are better off; and the rental on land (which is the specific factor in the other sector) falls, so landowners are worse off.

What happens if the price of the manufactured good falls? Then the inequalities are reversed, and the equation becomes

$$\underbrace{\Delta R_K/R_K}_{\substack{\text{Real rental}\\ \text{on capital falls}}} < \Delta P_M / P_M < \underbrace{\Delta W/W}_{\substack{\text{Change in the real}\\ \text{wage is ambiguous}}} < 0 < \underbrace{\Delta R_T/R_T}_{\substack{\text{Real rental}\\ \text{on land rises}}}, \text{ for a decrease in } P_M$$

In this case, wages fall but by less than the percentage decrease in the manufactured good; the rental on capital (which is specific to the manufacturing sector) falls by more than the manufacturing price, so capital owners are worse off; and the rental on land (which is the specific factor in the other sector) rises, so landowners are better off.

What happens if the *price of the agricultural good rises*? You can probably guess, based on the previous example, that this change will benefit land and harm capital. The equation summarizing the changes in all three factor earnings becomes

$$\underbrace{\Delta R_K/R_K}_{\substack{\text{Real rental}\\ \text{on capital falls}}} < 0 < \underbrace{\Delta W/W}_{\substack{\text{Change in the real}\\ \text{wage is ambiguous}}} < \Delta P_A / P_A < \underbrace{\Delta R_T/R_T}_{\substack{\text{Real rental}\\ \text{on land rises}}}, \text{ for an increase in } P_A$$

Note that it is the specific factor in the agricultural sector that gains and the specific factor in manufacturing that loses. The general result of these summary equations is that *the specific factor in the sector whose relative price has increased gains, the specific factor in the other sector loses, and labor is "caught in the middle," with its real wage increasing in terms of one good but falling in terms of the other*. These equations summarize the response of all three factor prices in the short run, when capital and land are specific to each sector but labor is mobile.

What It All Means

Our results from the specific-factors model show that the earnings of *specific factors* change the most from changes in relative prices due to international trade. Regardless of which good's price changes, the earnings of capital and land show the most extreme changes in their rentals, whereas the changes in the wages paid to labor are in the

middle. Intuitively, these extreme changes in factor prices occur because in the short run the specific factors are not able to leave their sectors and find employment elsewhere. In contrast, labor is able to move between sectors, and so the changes in the wage are not so extreme.

These results suggest that we ought to be able to find real-world examples in which a change in international prices leads to losses for either owners of capital or landowners. For labor, the key to avoiding falling wages is the ability to shift between sectors. Is it possible to design policies that encourage the movement of factors like labor? And for a specific factor like land, is it possible to offset the losses that can occur due to changing prices? In the next application we discuss several policies of this type.

APPLICATION

Can Losses to Factors of Production Be Offset?

Earnings of Labor Should the government step in to compensate workers who are looking for jobs or who do not find them in a reasonable period? The unemployment insurance program in the United States provides some compensation, regardless of the reason for the layoff. Moreover, the **Trade Adjustment Assistance (TAA)** program offers additional unemployment insurance payments and health insurance to workers who are laid off because of import competition. To receive this assistance, workers must enroll in a retraining program that will enable them to find a job in another industry. Recent economic studies have shown that the TAA program is effective in moving workers into industries with greater chances of lasting employment and higher earnings: about $50,000 cumulative extra earnings over 10 years.[18]

This program was started in the United States under President Kennedy in 1962. He believed that this program was needed to compensate those Americans who lost their jobs because of international trade. Since 1993 there was also a special TAA program under the North American Free Trade Agreement (NAFTA) for workers who were laid off as a result of import competition from Mexico or Canada. The TAA program was extended again in 2009, to allow workers outside of the manufacturing sector—in the service sector and also in agriculture—who lose their jobs because of trade to also apply for TAA benefits. The entire TAA program was reauthorized in 2015. Countries in Europe and elsewhere also have programs of this type.

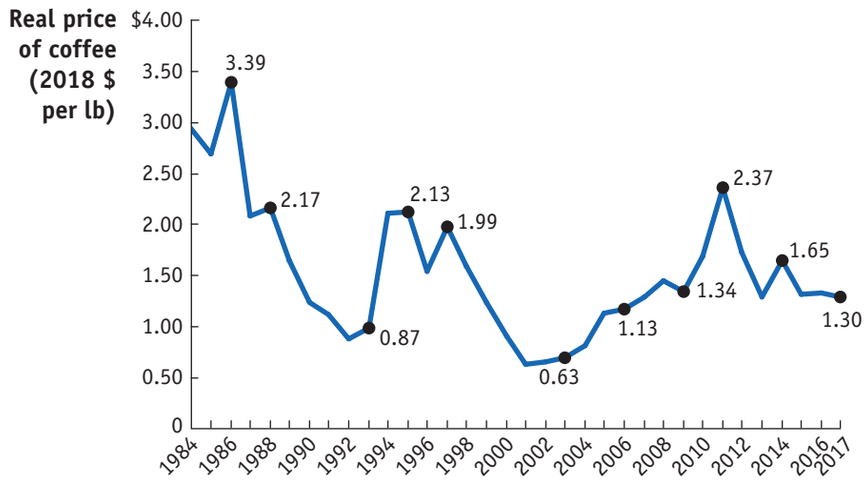
Earnings of Capital The United States also has a TAA program for firms that face strong competition from imports. For example, this program provides firms with matching funds to hire consultants, engineers, and other industry experts to assist in redesigning a manufacturing plant to make it more competitive. There are many instances in which these federal funds have helped a firm to survive.[19]

Earnings of Land Farmers often face changing prices on world markets, and when those prices fall, the real earnings of their land will fall even more, as our specific-factors model shows. Faced with declining real earnings in the agriculture sector, governments and other groups often take actions to prevent the incomes of farmers from falling.

An example of an agricultural commodity with particularly volatile prices is coffee. The price of coffee on world markets fluctuates a great deal from year to year because of weather and the entry of new suppliers in coffee-producing countries like Brazil and Vietnam. According to the specific-factors model, big fluctuations in coffee prices are extremely disruptive to the real earnings of landowners in coffee-exporting developing countries, many of whom are small farmers and their families.

[18] Benjamin G. Hyman, 2018, "Can Displaced Labor Be Retrained? Evidence from Quasi-Random Assignment to Trade Adjustment Assistance," University of Chicago.
[19] You are asked to investigate the TAA program for firms in Problem 1 at the end of the chapter.

FIGURE 3-12



World Coffee Market, 1984–2017
Real wholesale prices for coffee fluctuate greatly on world markets. Prices (in 2018 dollars) reached a high of $3.39 per pound in 1986, a low of $0.63 per pound in 2001, and in 2017 were at $1.30. These erratic price movements are due to short-term fluctuations in the weather and longer-term fluctuations in supply as countries expand their production.

Data from: International Coffee Organization, http://www.ico.org.

The movements in the real wholesale price of coffee (measured in 2018 dollars) are shown in Figure 3-12. Wholesale prices hit a high of $3.39 per pound in 1986 and fluctuated a lot over the next 30 plus years. In 2017, coffee prices were at $1.30 per pound. These dramatic fluctuations in prices create equally large movements in the real incomes of farmers, making it difficult for them to sustain a living. The very low price of $0.63 per pound in 2001 created a crisis in the coffee-growing regions of Central America, requiring humanitarian aid for farmers and their families. The governments of coffee-growing regions in Central America and Asia cannot afford to protect their coffee farmers by propping up prices, as the industrial countries can (and do).

Jutta Ulmer/mauritius images GmbH/Alamy

Harvesting Fair Trade coffee in Jaltenango, Chiapas, Mexico.

One idea that is gaining appeal as a way to help coffee farmers weather the kind of boom-and-bust cycles that occur regularly in coffee markets is to sell coffee from developing countries directly to consumers in industrial countries. By avoiding the middlemen (such as local buyers, millers, exporters, shippers, and importers), such an approach can ensure that farmers receive a higher price for their coffee. In addition, such programs help ensure a *more stable* price for farmers by guaranteeing them a minimum price, even if the market price falls lower.

You may have seen "fair-trade" coffee at your favorite coffeehouse. This coffee first appeared in the United States in 1999, imported by a group called TransFair USA—now called Fair Trade USA—that is committed to passing more of the profits back to the growers. Fair Trade USA is an example of a nongovernmental organization that is trying to help farmers by raising prices and allowing the consumer to choose whether to purchase this higher-priced product. Fair Trade USA also applies its Fair Trade label to imports of tea, cocoa, sugar, spices, honey, grains, wine, and other products.

Between 2004 and 2005, world coffee prices rose from $0.81 per pound to $1.13 per pound. When prices rose, groups like Fair Trade USA faced a dilemma because the fair-trade prices that they had guaranteed to farmers were actually lower than the world

HEADLINES

Rise in Coffee Prices—Great for Farmers, Tough on Co-ops

TransFair USA – now called Fair Trade USA – guarantees a minimum purchase price for coffee farmers, acting as insurance against a falling market price. But during periods when the market price is rising, it is challenging to ensure that farmers deliver their coffee. Such a rise in coffee prices occurred the drought in 2005, when the price of the Fair Trade contracts fell below the market price.

During winter and spring of the 2005 harvest, a dilemma surfaced in rural areas of Central America and Mexico. Fairtrade cooperative managers found it increasingly difficult to get members to deliver coffee to their own organization at fair-trade prices. The co-op managers were holding contracts that were set months before at fixed fair-trade prices ..., but now the world coffee price was higher. Growers were seeing some of the highest prices paid in five years, and the temptation was great to sell their coffee to the highest local bidder, instead of delivering it as promised to their own co-ops.

In most cases, the co-ops' leaders were able to convince farmers to deliver coffee, but often based on arguments of loyalty, as the fair-trade fixed price was now lower than the premium prices being offered by the local middleman. It was not the model that the founders of fair-trade coffee pricing had envisioned when they created the program.

"It's worth noting that we were pleased to see prices rise in late 2004," says Christopher Himes, TransFair USA's Director of Certification and Finance. "This price rise, in conjunction with the impact fair trade was already having, increased the income and living standards of coffee farmers around the world. The most challenging thing during this time for TransFair USA was the speed with which the local differentials [between the fair-trade price and the world price] rose in Indonesia. They quickly skyrocketed to 80 cents [per pound] or higher, making the market value of farmers' coffee higher than that of some of the . . . fair-trade contracts."

Source: David Griswold, http://www.FreshCup.com, June 2005.

price of coffee. The accompanying article **Headlines: Rise in Coffee Prices—Great for Farmers, Tough on Co-ops** describes how some farmers were tempted to break their contracts with local co-ops (at fixed, fair-trade prices) to deliver coffee to local middlemen at prevailing world prices. Fair Trade USA and similar organizations purchase coffee at higher than the market price when the market price is low, but in other years, they purchase coffee at lower than the market price when the market price is high. Essentially, Fair Trade USA is offering farmers a form of *insurance* whereby the fair-trade prices of coffee will not fluctuate too much. Farmers are thus protected against the highs and lows of fluctuating prices and are able to enjoy greater gains from trade by exporting their coffee. So when you consider buying a cup of fair-trade coffee at your favorite coffeehouse, you are supporting coffee farmers who rely on the efforts of groups like Fair Trade USA to raise their incomes, and you are applying the logic of the specific-factors model, all at the same time!

4 Conclusions

In the Ricardian model of Chapter 2, we showed that free trade could never make a country worse off, and in most cases free trade would make it better off. This result remains true for all factors of production: labor, land, and capital. As long as the relative price with international trade differs from the no-trade relative price, a country will gain from international trade. This conclusion does not mean, however, that each and every factor of production gains. On the contrary, we have shown in this chapter that the change in relative prices due to the opening of trade creates winners and

losers. Some factors of production gain in real terms, and other factors of production lose. To demonstrate this result, we have used a short-run model, in which labor is mobile between sectors but land and capital are each specific to their sectors.

Classical economists believed that, in the short run, factors of production that could not move between industries would lose the most from trade. We have found that this is true for the factor that is specific to the import-competing industry. That industry suffers a drop in its relative price because of international trade, which leads to a fall in the real rental on the specific factor in that industry. On the other hand, the specific factor in the export industry—whose relative price rises with the opening of trade—enjoys an increase in its real rental. Labor is mobile between the two industries, which allows it to avoid such extreme changes in wage: real wages rise in terms of one good but fall in terms of the other good, so we cannot tell whether workers are better off or worse off after a country opens to trade.

Economists have carefully proved that, in theory, the gains of individuals as a result of opening trade exceed the losses. This means that, in principle, the government should be able to tax the winners and use the additional tax revenue to compensate the losers so that everyone is better off because of trade. Sharing the gains from trade is very challenging in practice, however. In our opening story about Bolivia, it took a change in the country's government, which then took over the industry producing natural gas, to ensure that the gains were widely shared. In other countries, governments often use policies such as import tariffs and quotas that limit the amount of imports and that are intended to protect individuals from the effect of price changes resulting from international trade. We examine these policies later in the book.

KEY POINTS

1. Opening a country to international trade leads to overall gains, but in a model with several factors of production, some factors of production will lose.
2. The fact that some people are harmed because of trade sometimes creates social tensions that may be strong enough to topple governments. A recent example is Bolivia, where the citizens in the early 2000s could not agree on how to share the gains from exporting natural gas.
3. In the specific-factors model, factors of production that cannot move between industries will gain or lose the most when a country is opened to trade. The factor of production that is specific to the import industry will lose in real terms, as the relative price of the import good falls. The factor of production that is specific to the export industry will gain in real terms, as the relative price of the export good rises.
4. In the specific-factors model, labor can move between the industries and earns the same wage in each. When the relative price of either good changes, then the real wage rises when measured in terms of one good but falls when measured in terms of the other good. Without knowing how much of each good workers prefer to consume, we cannot say whether workers are better off or worse off because of trade.
5. Economists do not normally count the costs of unemployment as a loss from trade because people are often able to find new jobs. In the United States, for example, about two-thirds of people who are laid off from manufacturing or services companies find new jobs within three years, about one-half at lower wages and one-half at the same or higher wages.
6. The "China shock" refers to the impact on the U.S. labor market of China joining the WTO in 2001. Over 1999–2011, this shock led to a reduction in jobs within import and related industries of about 1.7 million workers in the United States. But over the longer period 1991–2011, the job losses in imports are nearly balanced with job gains in exports.
7. Even when many people are employed in export activities, such as those involved in coffee export from certain developing countries, fluctuations in the world market price can lead to large changes in income for workers in that industry.

KEY TERMS

specific-factors model, p. 63
diminishing returns, p. 63
autarky, p. 67
trade embargo, p. 67
real wage, p. 71
Engel's Law, p. 72
"China shock," p. 74
services, p. 74
rental on capital, p. 81
rental on land, p. 81
Trade Adjustment Assistance (TAA), p. 85

PROBLEMS

1. **Discovering Data** In this chapter, we learned that workers displaced by import competition are eligible for compensation through the Trade Adjustment Assistance (TAA) program. Firms are also eligible for support through Trade Adjustment Assistance for Firms, a federal program that provides financial assistance to manufacturers affected by import competition. Go to taacenters.org to read about this program, and then answer the following questions:
   a. Describe the criteria a firm has to meet to qualify for benefits.
   b. What amount of money is provided to firms, and for what purpose? Describe one of the "success stories," in which a firm used financial assistance to improve its performance.
   c. Provide an argument for and an argument against the continued funding of this federal program.
2. Why is the specific-factors model referred to as a short-run model?
3. Figure 3-7 presents wages in the manufacturing and services sectors for the period 1973 to 2018. Is the difference in wages across sectors consistent with either the Ricardian model studied in Chapter 2 or the specific-factors model? Explain why or why not.
4. In the gains from trade diagram in Figure 3-3, suppose that instead of having a rise in the relative price of manufactures, there is instead a fall in that relative price.
   a. Starting at the no-trade point A in Figure 3-3, show what would happen to production and consumption.
   b. Which good is exported and which is imported?
   c. Explain why the overall gains from trade are still positive.
5. Starting from equilibrium in the specific-factors model, suppose the price of manufactured goods falls so that wages fall from W' to W in Figure 3-5.
   a. Show that the percentage fall in wages is less than the percentage fall in the price of manufacturing so that the real wage of labor in terms of manufactured goods goes up.
   b. What happens to the real wage of labor in terms of agriculture?
   c. Are workers better off, are they worse off, or is the outcome ambiguous?

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6. Use the information given here to answer the following questions:

   Manufacturing:

   Sales revenue $= P_M \cdot Q_M = 150$

   Payments to labor $= W \cdot L_M = 100$

   Payments to capital $= R_K \cdot K = 50$

   Agriculture:

   Sales revenue $= P_A \cdot Q_A = 150$

   Payments to labor $= W \cdot L_A = 50$

   Payments to land $= R_T \cdot T = 100$

   Holding the price of manufacturing constant, suppose the increase in the price of agriculture is 20% and the increase in the wage is 10%.

   a. Determine the impact of the increase in the price of agriculture on the rental on land and the rental on capital.
   b. Explain what has happened to the real rental on land and the real rental on capital.

7. If instead of the situation given in Problem 6, suppose that the price of manufacturing were to fall by 20% and the wage declined by 10%. Then would landowners or capital owners be better off? Explain. How would the decrease in the price of manufacturing affect the real wage? Explain.

8. Read the article by Grant Aldonas, Robert Lawrence, and Matthew Slaughter, available online at: hks.harvard.edu/fs/rlawrence/fsf_adjustment_assistance_plan.pdf. Then answer the following questions.
   a. What is the name of the new program that these authors propose, and from what three programs in the United States would it combine elements?
   b. What is the authors' specific proposal for wage-loss insurance?
   c. What is their specific proposal for health insurance?
   d. What is their specific proposal for giving workers access to savings?
   e. Would the program they propose depend on a worker losing their job because of trade competition or a shift of production facilities overseas?
   f. What would their proposed program cost annually, and how does that compare with the annual cost of the Trade Adjustment Assistance program?
9. In the specific-factors model, assume that the price of agricultural goods decreases while the price of manufactured goods is unchanged ($\Delta P_A/P_A < 0$ and $\Delta P_M/P_M = 0$). Arrange the following terms in ascending order:

   $\Delta R_T/R_T \quad \Delta R_K/R_K \quad \Delta P_A/P_A \quad \Delta P_M/P_M \quad \Delta W/W$

   Hint: Try starting with a diagram like Figure 3-5, but change the price of agricultural goods instead.
10. Suppose two countries, Canada and Mexico, produce two goods: lumber and televisions. Assume that land is specific to lumber, capital is specific to televisions, and labor is free to move between the two industries. When Canada and Mexico engage in free trade, the relative price of televisions falls in Canada and the relative price of lumber falls in Mexico.
    a. In a graph similar to Figure 3-5, show how the wage changes in Canada due to a fall in the price of televisions, holding constant the price of lumber. Can we predict that change in the real wage?
    b. What is the impact of opening trade on the rentals on capital and land in Canada? Can we predict that change in the real rentals on capital and land?
    c. What is the impact of opening trade on the rentals on capital and land in Mexico? Can we predict that change in the real rentals on capital and land?
    d. In each country, has the specific factor in the export industry gained or lost, and has the specific factor in the import industry gained or lost?
11. Home produces two goods, computers and wheat, for which capital is specific to computers, land is specific to wheat, and labor is mobile between the two industries. Home has 100 workers and 100 units of capital but only 10 units of land.
    a. Draw a graph similar to Figure 3-1(a) with the output of wheat on the vertical axis and the labor used in wheat on the horizontal axis. What is the relationship between the output of wheat and the marginal product of labor in the wheat industry as more labor is used?
    b. Draw the production possibilities frontier for Home with wheat on the horizontal axis and computers on the vertical axis.
    c. Explain how the price of wheat relative to computers is determined in the absence of trade.
    d. Reproduce Figure 3-4 with the amount of labor used in wheat, measuring from left to right along the horizontal axis, and the amount of labor used in computers, moving in the reverse direction.
    e. Assume that as a result of international trade, the price of wheat rises. Analyze the effect of the increase in the price of wheat on the allocation of labor between the two sectors.
12. Similar to Home in Problem 11, Foreign also produces computers and wheat using capital, which is specific to computers; land, which is specific to wheat; and labor, which is mobile between the two sectors. Foreign has 100 workers and 100 units of land but only 10 units of capital. It has the same production functions as Home.
    a. Will the no-trade relative price of wheat be higher in Home or in Foreign? Explain why you expect this outcome.
    b. When trade is opened, what happens to the relative price of wheat in Foreign and to the relative price of wheat in Home?
    c. Based on your answer to (b), predict the effect of opening trade on the rental on land in each country, which is specific to wheat. What about the rental on capital, which is specific to computers?