in a factor and its exports of goods that use that factor intensively: *Countries tend to export goods whose production is intensive in factors with which the countries are abundantly endowed.*[7]

Trade and the Distribution of Income

We have just discussed how trade induces a convergence of relative prices. Previously, we saw that changes in relative prices, in turn, have strong effects on the relative earnings of labor and capital. A rise in the price of cloth raises the purchasing power of labor in terms of both goods while lowering the purchasing power of capital in terms of both goods. A rise in the price of food has the reverse effect. Thus, international trade can have a powerful effect on the distribution of income, even in the long run. In Home, where the relative price of cloth rises, people who get their incomes from labor gain from trade, but those who derive their incomes from capital are made worse off. In Foreign, where the relative price of cloth falls, the opposite happens: Laborers are made worse off and capital owners are made better off.

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

In our analysis of the specific factors case, we found that factors of production that are "stuck" in an import-competing industry lose from the opening of trade. Here, we find that factors of production that are used intensively by the import-competing industry are hurt by the opening of trade—regardless of the industry in which they are employed. Still, the theoretical argument regarding the aggregate gains from trade is identical to the specific factors case: Opening to trade expands an economy's consumption possibilities (see Figure 4-11), so there is a way to make everybody better off. However, one crucial difference exists regarding the income distribution effects in these two models. The specificity of factors to particular industries is often only a temporary problem: Garment makers cannot become computer manufacturers overnight, but given time the U.S. economy can shift its manufacturing employment from declining sectors to expanding ones. Thus, income distribution effects that arise because labor and other factors of production are immobile represent a temporary, transitional problem (which is not to say that such effects are not painful to those who lose). In contrast, effects of trade on the distribution of income among land, labor, and capital are more or less permanent.

Compared with the rest of the world, the United States is abundantly endowed with highly skilled labor while low-skilled labor is correspondingly scarce. This means that international trade has the potential to make low-skilled workers in the United States worse off—not just temporarily, but on a sustained basis. The negative effect of trade on low-skilled workers poses a persistent political problem, one that cannot be remedied by policies that provide temporary relief (such as unemployment insurance). Consequently, the potential effect of increased trade on income inequality in advanced economies such as the United States has been the subject of a large amount of empirical research. We review some of that evidence in the case study that follows, and conclude that trade has been, at most, a contributing factor to the measured increases in income inequality in the United States.

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[7]See Alan Deardorff, "The General Validity of the Heckscher-Ohlin Theorem," *American Economic Review* 72 (September 1982), pp. 683–694, for a formal derivation of this extension to multiple goods, factors, and countries.

CASE STUDY

North-South Trade and Income Inequality

The distribution of wages in the United States has become considerably more unequal since the 1970s. In 1970, a male worker with a wage at the 90th percentile of the wage distribution (earning more than the bottom 90 percent but less than the top 10 percent of wage earners) earned 3.2 times the wage of a male worker at the bottom 10th percentile of the distribution. By 2010, that worker at the 90th percentile earned more than 5.2 times the wage of the worker at the bottom 10th percentile. Wage inequality for female workers has increased at a similar rate over that same timespan. Much of this increase in wage inequality was associated with a rise in the premium attached to education, especially since the 1980s. In 1980, a worker with a college degree earned 40 percent more than a worker with just a high school education. This education premium rose steadily through the 1980s and 1990s to 80 percent. Since then, it has been roughly flat (though wage disparities among college graduates continued rising).

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

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

This is an argument with much more than purely academic significance. If one regards the growing inequality of income in advanced nations as a serious problem, as many people do, and if one also believes that growing world trade is the main cause of that problem, it becomes difficult to maintain economists' traditional support for free trade. (As we have previously argued, in principle, taxes and government payments can offset the effect of trade on income distribution, but one may argue that this is unlikely to happen in practice.) Some influential commentators

have argued that advanced nations will have to restrict their trade with low-wage countries if they want to remain basically middle-class societies.

While some economists believe that growing trade with low-wage countries has been the main cause of rising income inequality in the United States, most empirical researchers believed at the time of this writing that international trade has been at most a contributing factor to that growth, and that the main causes lie elsewhere.[8] This skepticism rests on three main observations.

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

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

Third, although trade between advanced countries and NIEs has grown rapidly, it still constitutes only a small percentage of total spending in the advanced nations. As a result, estimates of the "factor content" of this trade—the skilled labor exported, in effect, by advanced countries embodied in skill-intensive exports and the unskilled labor, in effect, imported in labor-intensive imports—are still only a small fraction of the total supplies of skilled and unskilled labor. This suggests that these trade flows couldn't have had a very large impact on income distribution.

What, then, *is* responsible for the growing gap between skilled and unskilled workers in the United States? The view of the majority is that the villain is not trade but rather new production technologies that put a greater emphasis on worker skills (such as the widespread introduction of computers and other advanced technologies in the workplace). This is often referred to as a technology-skill complementarity or **skill-biased technological change**.[9]

We discuss the links between this type of technological change and rising wage inequality in the following case study.

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[8]Among the important entries in the discussion of the impact of trade on income distribution have been Robert Lawrence and Matthew Slaughter, "Trade and U.S. Wages: Giant Sucking Sound or Small Hiccup?" *Brookings Papers on Economic Activity: Microeconomic* 2 (1993), pp. 161–226; Jeffrey D. Sachs and Howard Shatz, "Trade and Jobs in U.S. Manufacturing," *Brookings Papers on Economic Activity* 1 (1994), pp. 1–84; and Adrian Wood, *North-South Trade, Employment, and Income Inequality* (Oxford: Oxford University Press, 1994). For a survey of this debate and related issues, see Chapter 9 in Lawrence Edwards and Robert Z. Lawrence, *Rising Tide: Is Growth in Emerging Economies Good for the United States?* (Peterson Institute for International Economics, 2013).

[9]See Claudia Goldin and Lawrence F. Katz, "The Origins of Technology-Skill Complementarity," *The Quarterly Journal of Economics* (1998), pp. 693–732.

CASE STUDY

Skill-Biased Technological Change and Income Inequality

In this case study, we extend our two-factor production model to incorporate technological change that is skill-biased. We discuss how this provides a much better fit for the empirical patterns associated with rising wage inequality in the United States. We also describe some new research that links back portions of this technological change to trade and outsourcing.

Consider the variant of our two good, two factor model where skilled and unskilled labor are used to produce "high-tech" and "low-tech" goods. Figure 5-10 shows the relative factor demands for producers in both sectors: the ratio of skilled-unskilled workers employed as a function of the skilled-unskilled wage ratio (*LL* curve for low-tech and *HH* for high-tech).

We have assumed that production of high-tech goods is skilled-labor intensive, so the HH curve is shifted out relative to the LL curve. In the background, an SS curve

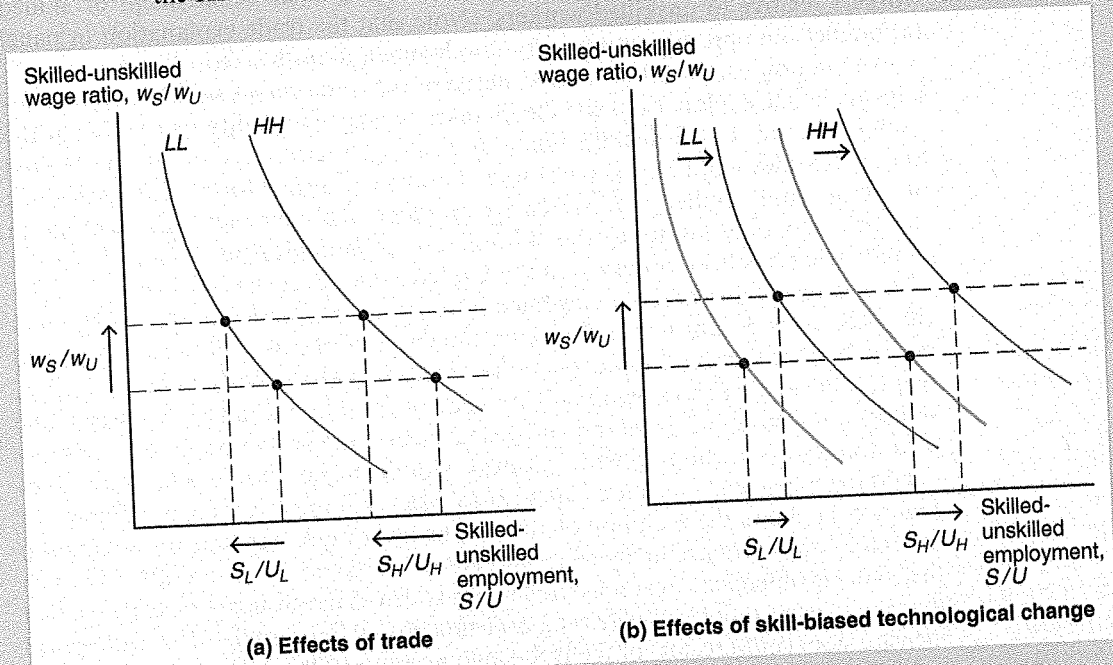

FIGURE 5-10

Increased Wage Inequality: Trade- or Skill-Biased Technological Change?

The *LL* and *HH* curves show the skilled-unskilled employment ratio, S/U, as a function of the skilled-unskilled wage ratio, w_S/w_U, in the low-tech and high-tech sectors. The high-tech sector is more skill-intensive than the low-tech sector, so the *HH* curve is shifted out relative to the *LL* curve. Panel (a) shows the case where increased trade with developing countries leads to a higher skilled-unskilled wage ratio. Producers in both sectors respond by *decreasing* their relative employment of skilled workers: S_L/U_L and S_H/U_H both decrease. Panel (b) shows the case where skill-biased technological change leads to a higher skilled-unskilled wage ratio. The *LL* and *HH* curves shift out (increased relative demand for skilled workers in both sectors). However, in this case producers in both sectors respond by *increasing* their relative employment of skilled workers: S_L/U_L and S_H/U_H both increase.

(see Figures 5-6 and 5-7) determines the skilled-unskilled wage ratio as an increasing function of the relative price of high-tech goods (with respect to low-tech goods).

In panel (a), we show the case where increased trade with developing countries generates an increase in wage inequality (the skilled-unskilled wage ratio) in those countries (via an increase in the relative price of high-tech goods). The increase in the relative cost of skilled workers induces producers in both sectors to *reduce* their employment of skilled workers relative to unskilled workers.

In panel (b), we show the case where technological change in both sectors generates an increase in wage inequality. This technology change is classified as "skill-biased" because it shifts out the relative demand for skilled workers in both sectors (both the *LL* and the *HH* curves shift out). It also induces larger productivity gains in the high-tech sector due to its complementarity with skilled workers. Thus, for any given relative price of high-tech goods, the technology change is associated with a higher skilled-unskilled wage ratio (the SS curve shifts). Even though skilled labor is relatively more expensive, producers in both sectors respond to the technological change by *increasing* their employment of skilled workers relative to unskilled workers. (Note that the trade explanation in panel (a) predicts an opposite response for employment in both sectors.)

We can now examine the relative merits of the trade versus skill-biased technological change explanations for the increase in wage inequality by looking at the changes in the skilled-unskilled employment ratio within sectors in the United States. A widespread increase in these employment ratios for all different kinds of sectors (both skilled-labor-intensive and unskilled-labor-intensive sectors) in the U.S. economy points to the skill-biased technological explanation. This is exactly what has been observed in the United States over the last half-century.

In Figure 5-11, sectors are separated into four groups based on their skill intensity. U.S. firms do not report their employment in terms of skill but use a related categorization of production and non-production workers. With a few exceptions, non-production positions require higher levels of education—and so we measure the skilled-unskilled employment ratio in a sector as the ratio of non-production employment to production employment.[10] Sectors with the highest non-production to production employment ratios are classified as most skill-intensive. Each quadrant of Figure 5-11 shows the evolution of this employment ratio over time for each group of sectors (the average employment ratio across all sectors in the group). Although there are big differences in average skill intensity across the groups, we clearly see that the employment ratios are increasing over time for all four groups. This widespread increase across most sectors of the U.S. economy is one of the main pieces of evidence pointing to the technology explanation for the increases in U.S. wage inequality.

Yet, even though most economists agree that skill-biased technological change has occurred, recent research has uncovered some new ways in which trade has been an indirect contributor to the associated increases in wage inequality, by accelerating this process of technological change. These explanations are based on the principle that firms have a choice of production methods that is influenced by openness to trade and foreign investment. For example, some studies show that firms that begin to export also upgrade to more skill-intensive production

[10]On average, the wage of a non-production worker is 60 percent higher than that of a production worker.

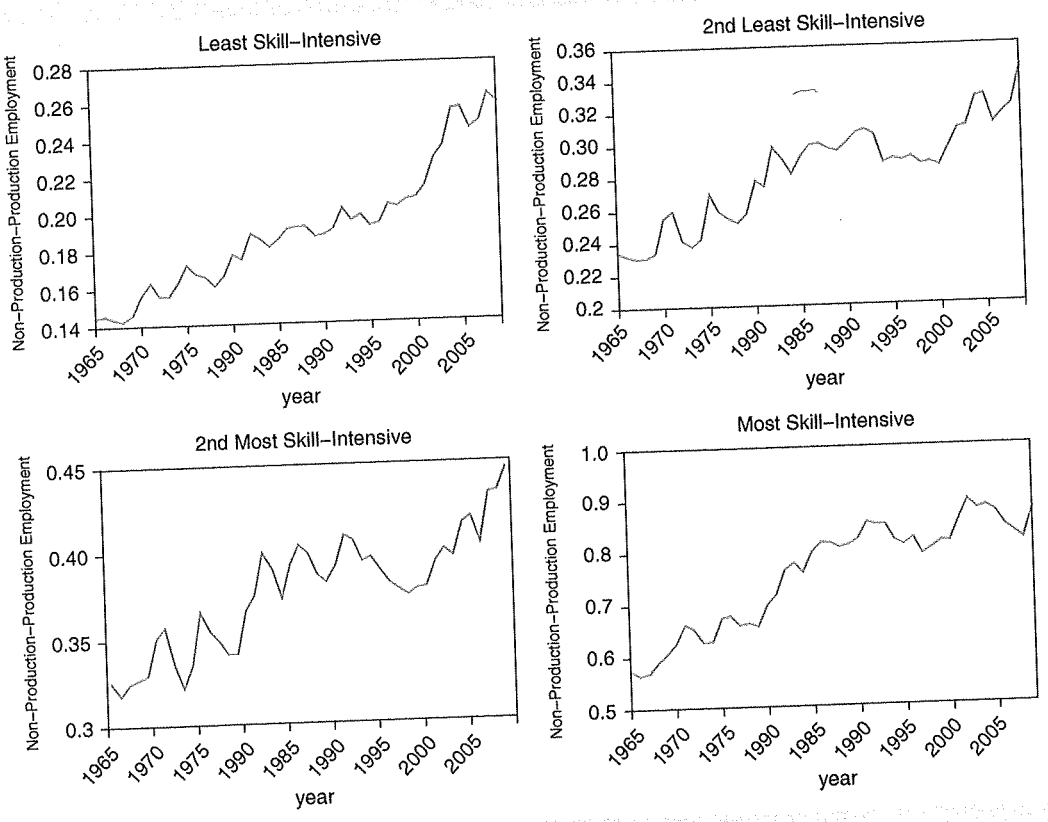

FIGURE 5-11

Evolution of U.S. Non-Production–Production Employment Ratios in Four Groups of Sectors

Sectors are grouped based on their skill intensity. The non-production–production employment ratio has increased over time in all four sector groups.

Source: NBER-CES Manufacturing Productivity Database

technologies. Trade liberalization can then generate widespread technological change by inducing a large proportion of firms to make such technology-upgrade choices.

Another example is related to foreign outsourcing and the liberalization of trade and foreign investment. In particular, the NAFTA treaty (see Chapter 2) between the United States, Canada, and Mexico has made it substantially easier for firms to move different parts of their production processes (research and development, component production, assembly, marketing) across different locations in North America. Because production worker wages are substantially lower in Mexico, U.S. firms have an incentive to move the processes that use production workers more intensively to Mexico (such as component production and assembly). The processes that rely more intensively on higher-skilled, non-production workers (such as research and development and marketing) tend to stay in the United States (or Canada). From the U.S. perspective, this break-up of the production process increases the relative demand for skilled workers and is very similar to skill-biased technological change. One study finds that this outsourcing process from the United States to Mexico can explain

21 to 27 percent of the increase in the wage premium between non-production and production workers.[11]

Thus, some of the observed skill-biased technological change, and its effect on increased wage inequality, can be traced back to increased openness to trade and foreign investment. And, as we have mentioned, increases in wage inequality in advanced economies are a genuine concern. However, the use of trade restrictions targeted at limiting technological innovations—because those innovations favor relatively higher-skilled workers—is particularly problematic: Those innovations also bring substantial aggregate gains (along with the standard gains from trade) that would then be foregone. Consequently, economists favor longer-term policies that ease the skill-acquisition process for all workers so that the gains from the technological innovations can be spread as widely as possible.

[11]See Robert Feenstra and Gordon Hanson, "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979–1990," *Quarterly Journal of Economics* 144 (August 1999), pp. 907–940.

Factor-Price Equalization

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

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

The surprising answer is that in the model, the tendency goes all the way. International trade leads to complete equalization of factor prices. Although Home has a higher ratio of labor to capital than Foreign, once they trade with each other, the wage rate and the capital rent rate are the same in both countries. To see this, refer back to Figure 5-6, which shows that given the prices of cloth and food, we can determine the wage rate and the rental rate without reference to the supplies of capital and labor. If Home and Foreign face the same relative prices of cloth and food, they will also have the same factor prices.

To understand how this equalization occurs, we have to realize that when Home and Foreign trade with each other, more is happening than a simple exchange of goods. In an indirect way, the two countries are in effect trading factors of production. Home lets Foreign use some of its abundant labor, not by selling the labor directly but by trading goods produced with a high ratio of labor to capital for goods produced with a low labor-capital ratio. The goods that Home sells require more labor to produce than the goods it receives in return; that is, more labor is *embodied* in Home's exports than in its imports. Thus Home exports its labor, embodied in its labor-intensive exports. Conversely, since Foreign's exports embody more capital than its imports, Foreign is indirectly exporting its capital. When viewed this way, it is not surprising that trade leads to equalization of the two countries' factor prices.

Although this view of trade is simple and appealing, there is a major problem with it: In the real world, factor prices are *not* equalized. For example, there is an extremely wide range of wage rates across countries (Table 5-1). While some of these differences