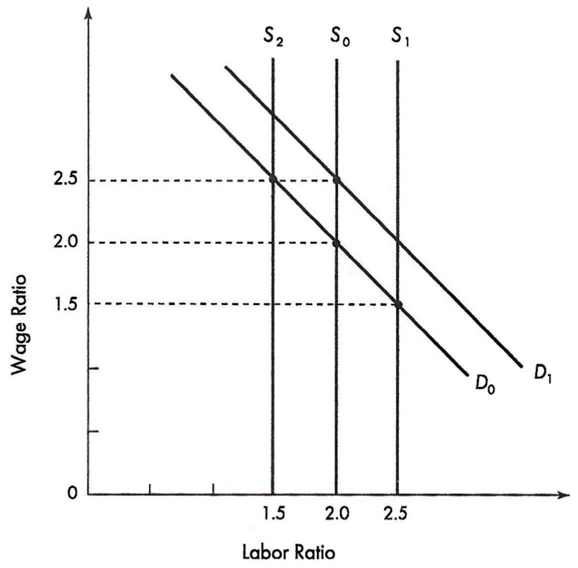
Figure 4.3 Inequality of Wages Between Skilled and Unskilled Workers



By increasing the demand for skilled relative to unskilled workers, expanding trade or technological improvements result in greater inequality of wages between skilled and unskilled workers. Also, immigration of unskilled workers intensifies wage inequality by decreasing the supply of skilled workers relative to unskilled workers. However, expanding opportunities for college education results in an increase in the supply of skilled relative to unskilled workers, thus reducing wage inequality. In the figure, the wage ratio equals wage of skilled workers/wage of unskilled workers. The labor ratio equals the quantity of skilled workers/quantity of unskilled workers.

Evidence on Wage Inequality

At the millennium, trade and immigration were targets of many disgruntled American workers. They cited large U.S. firms that fired workers at home and set up shop abroad and pointed to workers migrating from Mexico to the United States. However, economists have found that the effects of trade and immigration on the wage distribution have been small, implying that the vast majority of wage inequality is due to domestic factors, especially technology.

One study, by William Cline, estimated that technological change was about four times more powerful in widening wage inequality in the United States between 1973 and 1993 than trade, and that trade accounted for only seven percentage points of all the unequalizing forces at work during that period. That's only one study, but it is consistent with many studies. The consensus is that technological change has exerted a far stronger effect on wage inequality than trade.

The results of Cline's study are summarized in Table 4.1. It found that between 1973 and 1993, the ratio of skilled to unskilled wages increased by 18 percent. This was the net result of two opposing forces. First, there was an increase in the supply of skilled workers relative to the supply of unskilled workers, made possible by increased opportunities for education and train-

Table 4.1 Sources of the Increase in the Ratio of Skilled to Unskilled Wages in the United States, 1973–1993 (Percent)

A. Forces Causing Greater Inequality of Wages	
International trade	7
Lower transport and communication costs	3
Liberalization of trade barriers	3
Production sharing with other countries	1
Immigration	2
Stagnant minimum wage	5
Decline of labor unions	3
Skill-biased technological change	29
Unexplained	29
B. Forces Causing Greater Equality of Wages	
Increase in supply of skilled workers relative to unskilled workers	-40
C. Net Effect	18

Note: Percentages for unequalizing forces must be chained, not added, to equal total unequalizing effect. Similarly, "A" and "B" must be chained to calculate "C."

Source: William Cline, *Trade and Income Distribution*, Institute for International Economics, Washington, DC, 1997, p. 264.

ing. The increased relative supply of skilled workers drove down the ratio of skilled to unskilled wages, thus promoting wage equality. But at the same time, a variety of forces promoted wage inequality, and these unequalizing forces overwhelmed the equalizing forces. This resulted in an 18-percent net increase in the ratio of skilled to unskilled wages. Besides trade and technology, these unequalizing forces included immigration, stagnant minimum wage, and decline of unions.

Two things are striking about Cline's data. First, trade has been relatively unimportant in widening wage inequality. Second, trade's impact on wage inequality is overwhelmed not just by technology but also by the main force operating in the opposite direction—education and training. Indeed, the shifts in labor demand, away from less educated workers, are the most important factors behind the eroding wages of the less educated. Such shifts appear to be the result of economy-wide technological and organizational changes in how work is performed. The use of computers in the workplace has increased significantly in recent years. Not only has computerization led to the replacement of rote jobs (typing letters on an electric typewriter), but workers who use computers are generally paid higher wages than those who do not.

Policy Implications

The relatively small impact of trade on the inequality of skilled and unskilled wages means that skeptics of globalization miss the point if they are concerned mainly about the impact of globalization on adversely-affected workers in wealthy countries.

Indeed, some workers in wealthy countries do lose out from a combination of trade and technology. Yet just as a crusade against technology is not the solution to increased inequality resulting from technological progress, most economists argue that increased trade protection will not raise the relative wages of unskilled workers. A better solution involves better education and increased training to allow low-wage workers to take advantage of the technological changes that increase productivity.

Are Actual Trade Patterns Explained by the Factor-Endowment Theory?

The first attempt to investigate the factor-endowment theory empirically was undertaken by Wassily Leontief.[4] It had been widely recognized that in the United States capital was relatively abundant and labor was relatively scarce. According to the factor-endowment theory, *the United States should export capital-intensive goods and its import-competing goods should be labor-intensive.*

In 1954, Leontief tested this proposition by analyzing the capital/labor ratios for some 200 export industries and import-competing industries in the United States, based on trade data for 1947. As shown in Table 4.2, Leontief found that the capital/labor ratio for U.S. export industries was lower (about $14,000 per worker year) than that of its import-competing industries (about $18,000 per worker year). Leontief concluded that exports were *less* capital-intensive than import-competing goods! These findings, which contradicted the predictions of the factor-endowment theory, became known as the **Leontief paradox.**

Some economists maintained that 1947 was not a normal year, because the World War II reconstruction of the global economy had not been corrected by that time. To silence his critics, Leontief repeated his investigation in 1956, using 1951 trade data. Leontief again determined that U.S. import-competing goods were more capital-intensive than U.S. exports.

Since Leontief's time, many other studies have tested the predictions of the factor-endowment model. Although the tests conducted thus far are not conclusive, they seem to provide support for a more generalized factor-endowment model that takes into account many subvarieties of capital, land, and human factors and recognizes that factor endowments change over time as a result of investment and technological advances.

The upshot of a generalized factor-endowment model can be seen by looking at some trading patterns of the United States. Table 4.3 shows the shares of world resources for the United States in 1980. Compared with its other productive inputs, physical capital is relatively abundant in the United States (33.6 percent of world capital). In like manner, the United States is relatively well endowed with research and development scientists (50.7-percent share) and arable land (29.3-percent share); relative scarcities occur in semi-skilled labor (19.1-percent share) and unskilled labor (0.19-percent share).

Because the United States has a larger share of physical capital and R&D scientists than of world resources in total, the factor-endowment model predicts that the United States should have a comparative advantage in goods and services

[4] Wassily W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Reexamined," *Proceedings of the American Philosophical Society* 97, September 1953.

Table 4.2 Factor Content of U.S. Trade: Capital and Labor Requirements per Million Dollars of U.S. Exports and Import Substitutes

Empirical Study	Import Substitutes	Exports	Import/Export Ratio
Leontief			
Capital	$3,091,339	$2,550,780	
Labor (person years)	70	182	
Capital/person years	$18,184	$14,015	1.30

Source: W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Reexamined," *Economia Internazionale*, February 1954, pp. 3–32. See also W. Leontief, "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis," *Review of Economics and Statistics*, November 1956, pp. 386–407.

Table 4.3 Applying the Factor-Endowment Theory to the United States

Resource	U.S. Share of World* Resource Endowment	Product	U.S. Export/Import Ratio
Physical capital	33.6%	Technology-intensive	1.52
Skilled labor	27.7	Standardized	0.39
Semiskilled labor	19.1	Labor-intensive	0.38
Unskilled labor	0.19	Services	1.50
Arable land	29.3	Primary products	0.55
R&D scientists	50.7		

*Computed from a set of the 34 largest economies of the world.

Source: John Mutti and Peter Morici, *Changing Patterns of U.S. Industrial Activity and Comparative Advantage*, National Planning Association, Washington, DC, 1983; and World Bank, *World Development Report 1984*, Washington, DC, 1984, appendix table I.

that embody more scientific know-how and physical capital. This prediction is consistent with the 1980 export/import ratios for the United States, which are also shown in Table 4.3. The U.S. export/import ratios are greater than unity (that is, the United States is a net exporter) for technologically intensive manufactured goods (such as transportation equipment) and services (such as financial services and lending) that reflect U.S. technological know-how and past accumulation of physical capital. The United States is a net importer (the export/import ratio is less than unity) of standardized and labor-intensive manufactured goods (such as footwear and textiles). The situation represented in Table 4.3 is probably not much different today.

Early versions of the Heckscher–Ohlin model emphasized relative endowments of capital, labor, and natural resources as sources of comparative advantage. More recently, researchers have increasingly focused on the importance of worker *skills* in the creation of comparative advantage. Investments in skill, education, and training, which enhance a worker's productivity, create human capital in much the same manner that investments in machinery create physical capital. The United States is abundant in this human capital, including a well-educated and skilled labor force, relative to those of many other nations, as shown in Table 4.4. Therefore, the United States exports goods, such as jetliners and computer software, that use a highly skilled workforce intensively.

Researchers at the World Bank have analyzed the relationship between manufactures and primary products to relative supplies of skills and land, as shown in Figure 4.4. Their study included export data for 126 industrial and developing nations in 1985. Values along the horizontal axis of the figure denote the ratio of a nation's average educational attainment to its land area; values along the vertical axis indicate the ratio of manufactured exports to exports of primary products. In the figure, the regression line relates the division of each nation's exports between manufactures and primary products to its relative supplies of skills and land. The regression line suggests that nations endowed with relatively large amounts of skilled workers tend to emphasize the export of manufactures. Conversely, land-abundant nations tend to emphasize exports of primary products.

In spite of the appeal of the factor-endowment theory, not all empirical tests support its predictions. Many empirical studies have raised questions about the validity of this theory. The consensus among economists appears to be that factor endowments explain only a portion of trade patterns. Other determinants of trade patterns include technology, economies of scale, and economic policies, which we will examine throughout this chapter.

Table 4.4 U.S. Human Capital Relative to Those of Other Nations

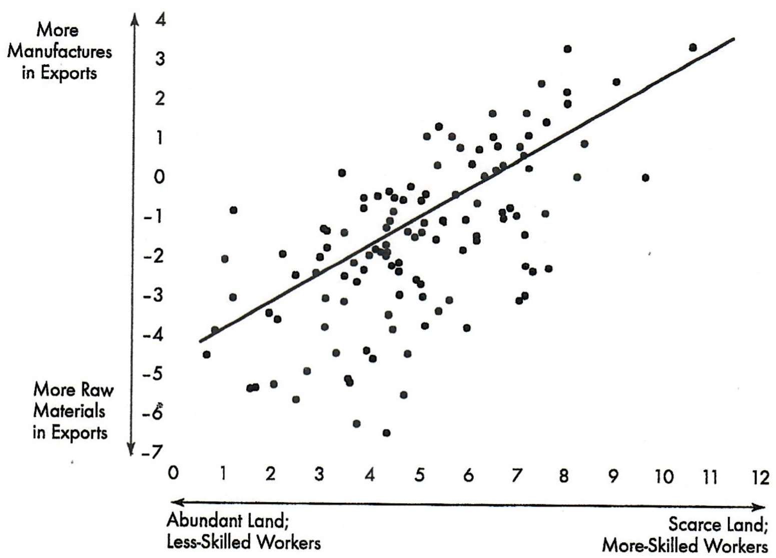
Although education captures only one aspect of human capital, it is the easiest to measure.

	School Enrollment as a Percent of Age Group*		
	Primary Education	Secondary Education	Tertiary** Education
United States	100	96	81
Germany	100	95	31
China	100	70	53
Russia	100	88	49
Mexico	100	66	31
Cambodia	99	39	23
Chile	90	85	43
Chad	48	18	14
Ethopia	35	25	36

*Enrollment ratios may exceed 100 percent because some pupils are younger or older than the country's standard age for a particular level of education.
**Tertiary education includes all postsecondary schools such as technical schools, junior colleges, colleges, and universities.

Source: World Bank, *Human Development Report*, Washington, DC, 2000. See also World Bank, *World Development Report.*

Figure 4.4 Heckscher-Ohlin, Skills, and Comparative Advantage



The regression line in the figure suggests that a nation endowed with more-skilled workers tends to have a comparative advantage in manufactures. Conversely, a land-abundant nation tends to have a comparative advantage in primary products.

Source: World Bank, *World Development Report 1995* (Geneva: World Bank, 1995), p. 59.

Economies of Scale and Specialization

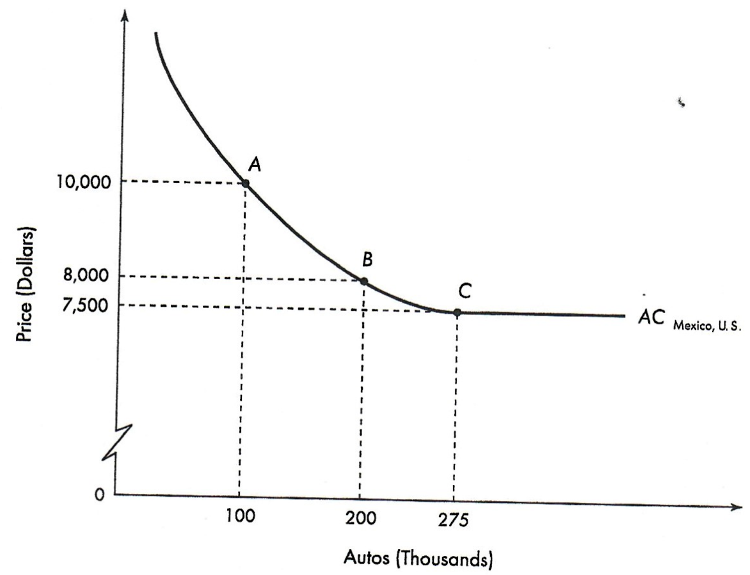
Another explanation of trade patterns involves efficiencies of large-scale production, which reduce a firm's per-unit costs. Such **economies of scale** are pronounced in industries that use mass-production techniques and capital equipment. The economic justification for economies of scale is that a large organization may reduce costs by specializing in machinery and labor, operating assembly-line production using its by-products, and obtaining quantity discounts obtained on the purchase of inputs.

How do economies of scale underlie a nation's comparative advantage? Adam Smith gave the answer in his 1776 classic, *The Wealth of Nations*, which stated that the division of labor is limited by the size of the market. By widening the size of a firm's market, international trade permits the firm to take advantage of longer production runs, which lead to increasing efficiency. An example is Boeing, which has sold about half of its jet planes overseas in recent years. Without exports, Boeing would have found it difficult to cover the large design and tooling costs of its jumbo jets, and the jets might not have been produced at all.

Figure 4.5 illustrates the effect of economies of scale on trade. Assume that a U.S. auto firm and a Mexican auto firm are each able to sell 100,000 vehicles in their respective countries. Also assume that identical cost conditions result in the same long-run average cost curve for the two firms, *AC*. Note that scale economies result in decreasing unit costs over the first 275,000 autos produced.

Initially, there is no basis for trade, because each firm realizes a production cost of $10,000 per auto. Suppose that rising income in the United States results in demand for 200,000 autos, while the Mexican auto demand remains constant. The

Figure 4.5 Economies of Scale as a Basis for Trade



By adding to the size of the domestic market, international trade permits longer production runs by domestic firms, which can lead to greater efficiency and reductions in unit costs.

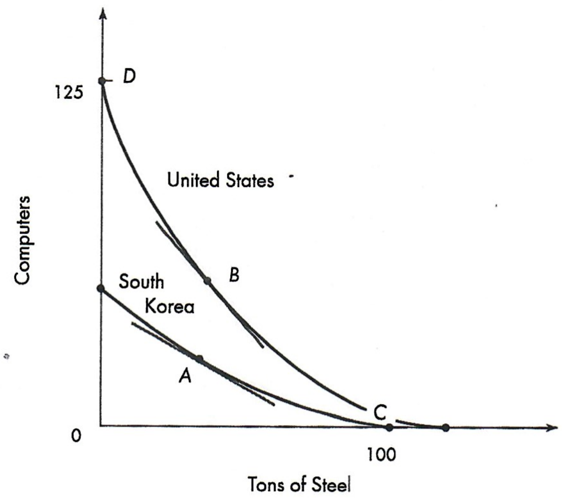
larger demand allows the U.S. firm to produce more output and take advantage of economies of scale. The firm's cost curve slides downward until its cost equals $8,000 per auto. Compared to the Mexican firm, the U.S. firm can produce autos at a lower cost. With free trade, the United States will now export autos to Mexico.

Economies of scale thus provide additional cost incentives for *specialization* in production. Instead of manufacturing only a few units of each and every product that domestic consumers desire to purchase, a country specializes in the manufacture of large amounts of a limited number of goods and trades for the remaining goods. Specialization in a few products allows a manufacturer to benefit from longer production runs, which lead to decreasing average costs.

How might trade operate with economies of scale? Figure 4.6 represents the production possibilities schedules of the United States and South Korea for computers and steel. Note that the two nations' production possibilities schedules are *bowed inward* (convex from the diagram's origin), indicating that the cost of producing steel becomes less and less in terms of computers sacrificed. At each point, the (absolute) slope of the production possibilities schedule reflects the cost of steel in terms of computers sacrificed.

Without trade, suppose South Korea and the United States desire both computers and steel. Both countries would have to manufacture some of each good at inefficient points, such as point *A* for South Korea and point *B* for the United States. Reflecting the (absolute) slopes of the production possibilities schedules at these points, South Korea has a comparative advantage in steel, while the United States has a comparative advantage in computers. The two countries should not remain for long at these inefficient production points. They can reduce costs by *specializing completely*

Figure 4.6 Trade and Specialization Under Decreasing Costs (Economies of Scale)



With decreasing costs, a country has the cost incentive to specialize completely in the product of its comparative advantage. Devoting additional resources to steel (computer) production results in economies of large-scale production and falling unit cost. With specialization, South Korea produces 100 tons of steel at point C, while the United States produces 125 computers at point D.