chapter 6

Economies of Scale, Imperfect Competition, and International Trade

LEARNING GOALS:

After reading this chapter, you should be able to:

- Explain how international trade can result from economies of scale
- Explain how product differentiation leads to intra-industry trade
- Understand the technological gap and product cycle models of trade
- Understand the relationship between transportation costs and environmental standards on international trade

6.1 Introduction

We have seen in Chapter 5 that the Heckscher–Ohlin theory based comparative advantage on differences in factor endowments among nations. The theory, however, leaves a significant portion of today's international trade unexplained. In this chapter, we fill this gap with some new, complementary trade theories, which base a great deal of international trade flows on economies of scale, imperfect competition, and differences in the development and spread of new technologies over time among nations.

Section 6.2 examines the effect of relaxing each of the assumptions on which the Heckscher–Ohlin theory rests. Section 6.3 examines international trade based on economies of scale. Section 6.4 shows the importance of imperfect competition as the basis of a great deal of today's international trade. Section 6.5 presents models that base international trade on differences in dynamic changes in technology among nations. Finally, Section 6.6 examines the effect of transportation costs and environmental standards on the location of industry and the flow of international trade. The appendix to this chapter examines external economies and their importance for international trade.

6.2 The Heckscher–Ohlin Model and New Trade Theories

In this section we relax the assumptions of the Heckscher–Ohlin theory discussed in Section 5.2. We will see that relaxing the assumptions does not affect the validity of the basic Heckscher–Ohlin model, but points to the need for new, complementary trade theories to explain the significant portion of international trade that the Heckscher–Ohlin theory leaves unexplained.

Relaxing the first assumption (two nations, two commodities, and two factors) to include more than two nations, more than two commodities, and more than two factors, while certainly complicating the analysis, leaves the H–O model basically valid, as long as the number of commodities is equal to or larger than the number of factors. One complication that arises in dealing with more than two factors is that we can no longer classify a commodity simply as *L* or *K* intensive but will require the construction of a factor-intensity *index* to predict the pattern of trade. This can be complex but should still be possible.

The second assumption of the Heckscher–Ohlin theory (i.e., that both nations use the same technology in production) is not generally valid. That is, nations often do use different technologies in the real world. However, technology can be regarded as a factor of production, and, as such, trade based on given technological differences among nations could be viewed as falling within the realm of the H–O theory. Trade based on *changes* in technology over time among nations is a different matter, however. These are explained by the technological gap and product cycle models. While these models could be regarded as dynamic extensions of the basic H–O model, they are in fact different and are discussed in Section 6.5.

The third assumption, that commodity X is the *L*-intensive commodity, while commodity Y is the *K*-intensive commodity in both nations, implies the absence of factor-intensity reversal. As pointed out in Section 5.6c, factor-intensity reversal would lead to the rejection of the H–O model. Empirical studies, however, indicate that factor-intensity reversal is not very common in the real world. It seems that the Leontief paradox could be eliminated by the inclusion of human capital, the exclusion of commodities intensive in natural resources, and comparing the *K/L* ratio in production versus consumption rather than in exports versus imports.

While the H–O theory assumed constant returns to scale (assumption 4), international trade can also be based on increasing returns to scale. Increasing returns to scale can be regarded as *complementary* to the H–O theory in that they try to explain a portion of international trade not covered by the basic H–O theory. Economies of scale as a basis for trade are examined in Section 6.3.

The fifth assumption of the H–O model was incomplete specialization in both nations. If trade brings about complete specialization in production in one of the nations, relative commodity prices will be equalized, but factor prices will not. For example, if in Figure 5.8 the amount of capital available to Nation 1 is so much less that point *B* (at which factor prices would be equalized in the two nations) is outside the Edgeworth box for Nation 1 (and therefore unattainable), factor prices will not be equalized in the two nations, even though relative commodity prices are.

Assumption 6 on equal tastes has been more or less verified empirically. Tastes are certainly not sufficiently different across nations to overcome differences in the relative *physical* availability of factors of production in explaining different relative commodity prices and trade among nations.

Relaxing assumption 7 of perfect competition in all product and factor markets is more troublesome. It seems that a significant portion of trade in manufactured goods among industrialized nations is based on product differentiation and economies of scale, which (at first sight at least) does not seem easily reconcilable with the H–O factor-endowment model. Such intra-industry trade is examined in Section 6.4.

Relaxing assumption 8 of no international factor mobility modifies but does not invalidate the H–O model. As pointed out in Section 5.5A, international factor mobility can be a substitute for international trade in bringing about equality of relative commodity and factor prices among nations. With some, but less than perfect, international factor mobility, the volume of trade required to bring about relative commodity and factor–price equalization would be less. This modifies the basic H–O model but does not take away its validity.

Similarly, costs of transportation and other nonprohibitive obstructions to the flow of international trade (assumption 9) reduce the volume and the benefits of international trade, but they only modify (rather than lead to the rejection of) the H–O theorem and the factor-equalization theorem. Costs of transportation and environmental standards are discussed in Section 6.6.

With resources not fully utilized (i.e., relaxing assumption 10), a potential comparative advantage based on unutilized or underutilized resources might not show through or emerge. The H–O theory would then incorrectly predict the pattern of trade. However, aside from temporary economic recessions and frictional unemployment (i.e., unemployment arising in the process of changing jobs), the full employment assumption is for the most part satisfied, at least in industrial countries.

Relaxing assumption 11, that international trade among nations is balanced, could lead a nation with a trade deficit to import some commodities in which it would have a comparative advantage and it would in fact export with balanced trade. Since most trade imbalances are generally not very large in relation to GNP, the charge that the H–O model might be unable to correctly predict the pattern of trade is true only for those commodities in which the nation has only a very small comparative advantage.

In conclusion, relaxing most of the assumptions of the Heckscher–Ohlin theory only modifies but does not invalidate the theory. Relaxing the assumptions of constant economies of scale and perfect competition, however, requires new, complementary trade theories to explain the significant portion of international trade that the H–O theory leaves unexplained. International trade based on differences in technological changes over time among nations also calls for new trade theories. We now turn to these new, complementary trade theories.

6.3 Economies of Scale and International Trade

One of the assumptions of the H–O model was that both commodities were produced under conditions of constant returns to scale in the two nations (assumption 4 in Section 5.2). With increasing returns to scale, mutually beneficial trade can take place even when the two nations are identical in every respect. This is a type of trade that the H–O model does not explain.

Increasing returns to scale refers to the production situation where output grows proportionately more than the increase in inputs or factors of production. That is, if all inputs are doubled, output is more than doubled. If all inputs are tripled, output is more than tripled.

Increasing returns to scale may occur because at a larger scale of operation a greater division of labor and specialization becomes possible. That is, each worker can specialize in performing a simple repetitive task with a resulting increase in productivity. Furthermore, a larger scale of operation may permit the introduction of more specialized and productive machinery than would be feasible at a smaller scale of operation. *Antweiler and Trefler* (2002) found that a third of all goods-producing industries are characterized by increasing returns to scale.

Figure 6.1 shows how mutually beneficial trade can be based on increasing returns to scale. If the two nations are assumed to be identical in every respect, we can use a single production frontier and a single indifference map to refer to both nations. Increasing returns to scale result in production frontiers that are *convex* from the origin, or inward-bending. With identical production frontiers and indifference maps, the no-trade equilibrium relative commodity prices in the two nations are also identical. In Figure 6.1, this is $P_X/P_Y = P_A$ in both nations and is given by the slope of the common tangent to the production frontier and indifference curve I at point A.

With trade, Nation 1 could specialize completely in the production of commodity X and produce at point B. Nation 2 would then specialize completely in the production of commodity Y and produce at point B'. By then exchanging 60X for 60Y with each other, each nation would end up consuming at point E on indifference curve II, thus gaining 20X and 20Y. These gains from trade arise from economies of scale in the production of only one commodity in each nation. In the absence of trade, the two nations would not specialize in the production of only one commodity because each nation wants to consume both commodities.

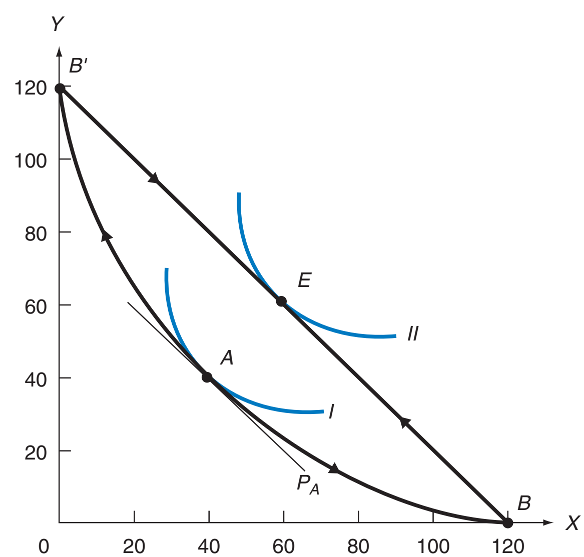

FIGURE 6.1. Trade Based on Economies of Scale.
With identical and convex to the origin (because of economies of scale) production frontiers and indifference maps, the no-trade equilibrium-relative commodity price in the two nations is identical and given by P_A. With trade, Nation 1 could specialize completely in the production of commodity X and produce at point *B*. Nation 2 would then specialize completely in the production of commodity Y and produce at point *B*′. By then exchanging 60X for 60Y with each other, each nation would end up consuming at point *E* on indifference curve *II*, thus gaining 20X and 20Y.

Note that the no-trade equilibrium point A is unstable in the sense that if, for whatever reason, Nation 1 moves to the right of point A along its production frontier, the relative price of X (the slope of the production frontier) will fall and will continue to fall until Nation 1 becomes completely specialized in the production of commodity X. Similarly, if Nation 2 moves to the left of point A along its production frontier, P_X/P_Y will rise (so that its inverse, P_Y/P_X, falls) until Nation 2 becomes completely specialized in the production of commodity Y.

Several additional aspects of the preceding analysis and Figure 6.1 must be clarified. First of all, it is a matter of complete indifference which of the two nations specializes in the production of commodity X or commodity Y. In the real world, this may result from historical accident. Second, it should be clear, at least intuitively, that the two nations need not be identical in every respect for mutually beneficial trade to result from increasing returns to scale. Third, if economies of scale persist over a sufficiently long range of outputs, one or a few firms in the nation will capture the entire market for a given product, leading to monopoly (a single producer of a commodity for which there is no close substitute) or oligopoly (a few producers of a homogeneous or differentiated product).

Fourth, since the early 1980s, there has been a sharp increase in international trade in parts and components through outsourcing and offshoring, and these are the source of new and significant international economies of scale. Outsourcing refers to the purchase by a firm of parts and components abroad in order to keep its costs down. Offshoring refers, instead, to a firm producing in its own plants abroad some of the parts and components that it uses in its products. While outsourcing and offshoring lead to international economies of scale (see Case Study 6-1), they also lead to complaints that a significant number of high-paying jobs are transferred abroad (see Case Study 6-2).

CASE STUDY 6-1 The New International Economies of Scale

Today, more and more products manufactured by international corporations have parts and components made in many different nations (see Case Study 1-1). The reason is to minimize production costs. For example, the motors of some Ford Fiestas are produced in the United Kingdom, the transmissions in France, the clutches in Spain, and the parts are assembled in Germany for sales throughout Europe. Similarly, Japanese and German cameras are often assembled in Singapore to take advantage of cheaper labor there.

Foreign "sourcing" of inputs is often not a matter of choice to earn higher profits, but simply a requirement to remain competitive. Firms that do not look abroad for cheaper inputs face loss of competitiveness in world markets and even in the domestic market. U.S. firms now spend more than \$100 billion on outsourcing, and by doing so they cut costs by 10 to 15 percent. Outsourcing now accounts for more than one-third of total manufacturing costs by Japanese firms, and this saves them more than 20 percent of production costs.

Firms must constantly explore sources of cheaper inputs and overseas production in order to remain competitive in our rapidly shrinking world. Indeed, this process can be regarded as manufacturing's *new international economies of scale* in today's global economy. Just as companies were forced to rationalize operations within each country in the 1980s, they now face the challenge of integrating their operations for their entire system of manufacturing around the world in order to take advantage of these new international economies of scale. What is important is for the firm to focus on its core competency (i.e., in the production of) those components that are indispensable to the company's competitive position over subsequent product generations and outsource

(continued)

CASE STUDY 6-1 Continued

other components in which outside suppliers have a distinctive production advantage. These new international economies of scale are likely to become even more important in the future as we move closer and closer to a truly global economy.

Sources: "Manufacturing's New Economies of Scale," *Harvard Business Review*, May–June 1992, pp. 94–102; "How to Think Strategically about Outsourcing," *Harvard Management Update*, May 2000, pp. 4–6; and D. Salvatore, "The U.S. Challenge to European Firms," *European Journal of International Management*, Vol. 1, No. 1, 2007, pp. 69–80.

CASE STUDY 6-2 Job Loss Rates in U.S. Industries and Globalization

Table 6.1 shows that, from 2003 to 2005, the percentage of jobs lost in U.S. manufacturing was three times higher than in U.S. service industries, but in all sectors (except professional and business services) job losses were much higher in the nontradable than in the tradable sectors (and thus not caused by increased imports, outsourcing, or offshoring). As discussed in Case Study 3-4, most *direct* job losses in the United States resulted from technological changes that raised labor productivity rather than from international trade itself, and it affected mostly low-skilled industrial workers. As debated by *Samuelson* (2004), *Bhagwati* (2007), *Blinder* (2008), *Coe* (2008), *Summers* (2008), and *Harrison and McMillan* (2011), the fear now is that the revolution in telecommunications and transportation is making possible the export of an increasing number of high-skill and high-paying jobs, not only in manufacturing but also in a growing range of services that until recently were regarded as secure. In fact, *Barefoot and Mataloni* (2011) found that from 1999 to 2009 U.S. multinational corporations cut their workforce in the United States by nearly 900,000 while at the same time expanding it by 2.9 million workers abroad.

TABLE 6.1. U.S. Job Loss Rates by Industry (Percent)

Industry	Overall	Tradable	Nontradable
Manufacturing	12	12	17
Information	4	4	15
Financial Services	4	3	12
Professional & Business Services	4	6	3

Source: A. Bradword and L. G. Kletzer "Fear of Offshoring: The Scope and Potential Impact of Imports and Exports of Services," *Policy Brief*, Petersen Institute, January 2008.

Economies of scale or increasing returns to scale must also be clearly distinguished from external economies. The former refer to the reduction in the average costs of production as *the firm's output expands*. Thus, economies of scale or increasing returns to scale are internal to the firm. External economies, on the other hand, refer to the reduction (i.e., downward shift) in each firm's average cost of production curve *as the entire industry output expands* (i.e., for reasons external to the firm). External economies and their importance for international trade are examined in the appendix to this chapter.

Finally, and somewhat related to economies of scale, is the hypothesis advanced by *Linder* in 1961 that a nation exports those manufactured products for which a large domestic market exists. These are products that appeal to the majority of the population. In the process of satisfying such a market, the nation acquires the necessary experience and efficiency to be able subsequently to export these commodities to other nations with similar tastes and income levels. The nation will import those products that appeal to its low- and high-income minorities. According to this “preference similarity” or “overlapping demands” hypothesis, trade in manufactures is likely to be largest among countries with similar tastes and income levels. While confirmed for his native Sweden, Linder’s hypothesis has not been confirmed for other nations. It also cannot explain, for example, why such non-Christian nations as Japan and Korea export artificial Christmas trees and Christmas cards in the absence of a domestic market for these products.

6.4 Imperfect Competition and International Trade

In this section, we examine the very important relationship between imperfect competition and international trade, first from an intuitive level and then with a formal model. We also discuss a method of measuring intra-industry trade.

6.4A Trade Based on Product Differentiation

A large portion of the output of modern economies today involves differentiated rather than homogeneous products. Thus, a Chevrolet is not identical to a Toyota, a Volkswagen, a Volvo, or a Renault. As a result, a great deal of international trade can and does involve the exchange of differentiated products of the same industry or broad product group. That is, a great deal of international trade is intra-industry trade in differentiated products, as opposed to inter-industry trade in completely different products (see Case Study 6-3).

CASE STUDY 6-3 U.S. Intra-Industry Trade in Automotive Products

Table 6.2 shows U.S. imports from and exports of automotive products (automobiles and automobile parts, engines, and bodies) to Canada, Mexico, Europe, and Japan in 1965, 1973, 1980, 1985, 1990, 1995, 2000, 2005, and 2010. Automobile and automotive products of various producers in different nations are not identical but differentiated and thus give rise to intra-industry trade. The very rapid growth of U.S. intra-industry trade in automotive products between 1965 and 2010 was due to the reduction in trade protection and transportation costs and, in the case of U.S. trade with Canada, to the U.S.-Canadian auto agreement of 1965, which established free trade for these products between the two countries. This enabled Canada to reduce the number of models it produced (thereby achieving greater economies of scale in production), while at the same time increasing the number of models available to Canadian consumers through imports from the United States. U.S.-Mexican intra-industry trade in automotive products also grew very rapidly as a result of NAFTA (North American Free Trade Agreement), which took effect on January 1, 1994. NAFTA is discussed in detail in Chapter 10. In the future, big-car production is likely to be concentrated in the United States and Canada, while small-car production is likely to shift to Mexico. Note the largely two-way nature of U.S. trade in automotive products with Canada, Mexico, and Latin America, as opposed to the mostly one-way trade with Japan. The decline in trade in automotive products in 2010 (except with Mexico) was due to the slow growth in the world economy.

(continued)

CASE STUDY 6-3 Continued

TABLE 6.2. U.S. Imports and Exports of Automotive Products (billions of dollars)

Year	Canada	Mexico	Europe	Japan	World
Imports					
1965	.11	–	.07	.01	.19
1973	4.92	–	3.14	2.41	10.55
1980	7.87	.22	6.73	11.85	26.94
1985	20.77	2.93	11.84	24.55	58.57
1990	27.71	4.39	13.27	30.12	79.32
1995	41.63	12.11	15.65	34.94	108.02
2000	58.75	28.30	29.11	44.49	170.20
2005	64.42	29.86	43.06	49.37	205.45
2010	47.96	43.73	33.63	42.92	189.76
Exports					
1965	.62	–	.07	–	.87
1973	4.12	–	.48	.09	6.03
1980	9.54	1.35	1.46	.19	16.74
1985	16.32	2.72	1.15	.21	21.07
1990	19.48	3.57	3.65	1.52	32.55
1995	28.94	5.14	5.45	4.07	52.51
2000	38.23	13.28	6.55	2.73	67.20
2005	45.77	13.55	10.41	1.45	85.99
2010	43.05	17.14	9.73	1.24	99.51

Source: WTO, *International Trade Statistics* (Geneva, various issues).

Intra-industry trade arises in order to take advantage of important economies of scale in production. That is, international competition forces each firm or plant in industrial countries to produce only one, or at most a few, varieties and styles of the same product rather than many different varieties and styles. This is crucial in keeping unit costs low. With few varieties and styles, more specialized and faster machinery can be developed for a continuous operation and a longer production run. The nation then imports other varieties and styles from other nations. Intra-industry trade benefits consumers because of the wider range of choices (i.e., the greater variety of differentiated products) available at the lower prices made possible by economies of scale in production. Case Study 6-4 examines the large welfare gains that arise from the ability of consumers to greatly increase the variety of goods that they can purchase with trade.

The importance of intra-industry trade became apparent when tariffs and other obstructions to the flow of trade among members of the European Union, or Common Market, were removed in 1958. *Balassa* found that the volume of trade surged, but most of the increase involved the exchange of differentiated products *within* each broad industrial classification. That is, German cars were exchanged for French and Italian cars, French washing machines were exchanged for German washing machines, Italian typewriters for German and French typewriters, and so on.

Even before the formation of the European Union, plant size in most industries was about the same in Europe and the United States. However, unit costs were

CASE STUDY 6-4 Variety Gains with International Trade

Until now, the welfare gains from trade have been measured by the reduction in the price of imported goods and their greater consumption. But another very important gain from trade arises from the large increase in the variety of goods available for consumers to purchase as a result of international trade. *Broda and Weinstein* estimate that American consumers would have been willing to pay an extra $280 billion, or about 3 percent of GDP, to have access to the variety of goods that were available in 2001, rather than what they could have bought in 1972. The number of varieties of goods available to American consumers increased from 74,667 (7,731 more goods from an average of 9.7 countries) in 1972 to 259,215 (16,390 goods from an average of 15.8 countries) in 2001. The authors estimate that the conventional import price index, therefore, overestimates the price of imports by about 1.2 percent per year by not taking into account the higher value that variety brings.

The gains from trade resulting from making available to consumers a much larger variety of each type of good are much greater for developing countries that only recently opened up more widely to international trade. China is the country that received the largest gain—a whopping 326.1 percent of GDP—from the much greater variety of goods available in 1997 (after China opened up its economy to international trade) compared to those available to Chinese consumers in 1972 (when China was, for the most part, a closed economy). The former Soviet Union follows with a gain of 213.7 percent of GDP. There is then South Korea with a gain of 185.3 percent of GDP and Taiwan with 126.9 percent gain. In fact, all the other 19 countries that the authors study had gains in the double digits (as compared with a gain of 3 percent of GDP for the United States), because the U.S. economy has always been one of the most open during the past three decades covered by the study (and therefore the one that gained the least as a percentage of GDP). From their study of U.S. automobile imports, *Blonigen and Soderbery* (2010) believe, however, that U.S. net gain from variety is likely to be much greater.

Sources: C. Broda and D. Weinstein, "Are We Underestimating the Gains from Globalization for the United States?" *Current Issue in Economics and Finance*, Federal Reserve Bank of New York, April 2005, pp. 1–7; C. Broda and D. Weinstein, "Variety Growth and World Welfare," *American Economic Review*, May 2005, pp. 139–144; and B. A. Blonigen and A. Soderbery, "Measuring the Benefits of Foreign Products Variety with an Accurate Variety Set," *Journal of International Economics*, November 2010, pp. 168–180.

much higher in Europe, primarily because European plants produced many more varieties and styles of a product than did their American counterparts. As tariffs were reduced and finally eliminated and trade expanded within the European Union, each plant could specialize in the production of only a few varieties and styles of a product, and unit costs fell sharply as a result.

Several other interesting considerations must be pointed out with respect to the intra-industry trade models developed by *Helpman, Krugman, Lancaster*, and others since 1979. First, although trade in the H–O model is based on comparative advantage or differences in factor endowments (labor, capital, natural resources, and technology) among nations, intra-industry trade is based on product differentiation and economies of scale. Thus, while trade based on comparative advantage is likely to be larger when the difference in factor endowments among nations is greater, intra-industry trade is likely to be larger among industrial economies of similar size and factor proportions (when factors of production are broadly defined).

Second, with differentiated products produced under economies of scale, pretrade-relative commodity prices may no longer accurately predict the pattern of trade. Specifically, a large country may produce a commodity at lower cost than a smaller country in the absence of trade because of larger national economies of scale. With trade, however, all countries can take advantage of economies of scale to the same extent, and the smaller country could conceivably undersell the larger nation in the same commodity.

Third, in contrast to the H–O model, which predicts that trade will lower the return of the nation's scarce factor, with intra-industry trade based on economies of scale it is possible for all factors to gain. This may explain why the formation of the European Union and the great postwar trade liberalization in manufactured goods met little resistance from interest groups. This is to be contrasted to the strong objections raised by labor in industrial countries against liberalizing trade with some of the most advanced of the developing countries because this trade, being of the inter- rather than of the intra-industry trade type, could lead to the collapse of entire industries (such as the textile industry) and involve lower real wages and massive reallocations of labor to other industries in industrial nations.

Finally, intra-industry trade is related to the sharp increase in international trade in parts and components of a product, or outsourcing. As we have seen in Case Study 6-1, international corporations often produce or import various parts of a product in different nations in order to minimize their costs of production (international economies of scale). The utilization of each nation's comparative advantage to minimize total production costs can be regarded as an extension of the basic H–O model to modern production conditions. This pattern also provides greatly needed employment opportunities in some developing nations. We will return to this topic in Chapter 12, which deals with international resource movements and multinational corporations.

The tentative conclusion that can be reached, therefore, is that comparative advantage seems to determine the pattern of *inter-industry trade*, while economies of scale in differentiated products give rise to *intra-industry trade*. Both types of international trade occur in today's world. The more dissimilar are factor endowments (as between developed and developing countries), the more important are comparative advantage and inter-industry trade. On the other hand, intra-industry trade is likely to be dominant the more similar are factor endowments broadly defined (as among developed countries). As *Lancaster* (1980) pointed out, however, even in the case of intra-industry trade, "comparative advantage is somewhere in the background." One could say that inter-industry trade reflects *natural* comparative advantage while intra-industry trade reflects *acquired* comparative advantage.

More importantly, the more recent empirical tests of the H–O theory discussed in Section 5.6 showed that by allowing for differences in technology and factor prices across countries, for the existence of nontraded goods and transportation costs, and by utilizing more disaggregated factor endowments and trade data, a great deal of intra-industry trade is in fact based on international differences in factor endowments and comparative costs. Thus, there seems to be much less conflict between intra-industry and the H–O theories than might appear at first sight. That is, a great deal of intra-industry trade is in fact consistent with trade based on differences in factor endowments and comparative costs. For example, the importation of a computer from Mexico by the United States may in fact involve the re-export of U.S. computer chips produced with highly skilled U.S. labor, as well as the export of other less-skilled Mexican labor embodied into the computer.

6.4B Measuring Intra-Industry Trade

The level of intra-industry trade can be measured by the intra-industry trade index (T):

$$T = 1 - \frac{|X - M|}{X + M} \tag{6-1}$$

where X and M represent, respectively, the value of exports and imports of a particular industry or commodity group and the vertical bars in the numerator of Equation (6-1) denote the absolute value. The value of T ranges from 0 to 1. $T = 0$ when a country only exports or only imports the good in question (i.e., there is no intra-industry trade). On the other hand, if the exports and imports of a good are equal, $T = 1$ (i.e., intra-industry trade is maximum).

Grubel and Lloyd calculated the T index for various industries in 10 industrial countries for the year 1967. They found that the weighted average of T for the 10 industrial countries

CASE STUDY 6-5 Growth of Intra-Industry Trade

Table 6.3 presents data on the share of intra-industry trade in manufactured products of industrial countries in 1988–1991 and 1996–2000. The table shows that in 1996–2000, France had the highest level of intra-industry trade (77.5), followed by Canada (76.2) and Austria (74.2). For the other G-7 countries, the United Kingdom had an index of 73.7, Germany 72.0, the United States 68.5, Italy 64.7, and Japan 47.6. The highest indices were for European countries (except for Canada, Mexico, and the United States) and the lowest were for Pacific and developing countries (except for Norway and Greece). The highest percentage growth in the index between the two periods was for Hungary, Korea, Mexico, and Japan. For some countries (such as Belgium/Luxembourg, Greece, and Ireland), the index actually declined.

TABLE 6.3. Manufacturing Intra-Industry Trade as a Percentage of Total Manufacturing Trade in Selected Countries

Country	1988–1991	1996–2000	Country	1988–1991	1996–2000
France	75.9	77.5	Denmark	61.6	64.8
Canada	73.5	76.2	Italy	61.6	64.7
Austria	71.8	74.2	Poland	56.4	62.6
United Kingdom	70.1	73.7	Portugal	52.4	61.3
Mexico	62.5	73.4	Korea	41.4	57.5
Hungary	54.9	72.1	Ireland	58.6	54.6
Switzerland	69.8	72.0	Finland	53.8	53.9
Germany	67.1	72.0	Japan	37.6	47.6
Belgium/Luxembourg	77.6	71.4	New Zealand	37.2	40.6
Spain	68.2	71.2	Turkey	36.7	40.0
Netherlands	69.2	68.9	Norway	40.0	37.1
United States	63.5	68.5	Greece	42.8	36.9
Sweden	64.2	66.6	Australia	28.6	29.8

Source: OECD, "Intra-Industry Trade," *Economic Outlook* (Paris: OECD, June 2002), pp. 159–163.

ranged from 0.30 for mineral fuels, lubricants, and related industries to 0.66 for chemicals, for an overall or combined weighted average of T for all industries in all 10 countries of 0.48. This means that in 1967 nearly half of all the trade among these 10 industrial countries involved the exchange of differentiated products of the same industry. The value of T has also risen over time. It was 0.36 in 1959, 0.42 in 1964, and 0.48 in 1967. Case Study 6-5 presents some more recent estimates of intra-industry trade for the leading industrial and developing countries.

There is a serious shortcoming in using the index T to measure the degree of intra-industry trade, however. This results from the fact that we get very different values for T, depending on how broadly we define the industry or product group. Specifically, the more broadly we define an industry, the greater will be the value of T. The reason for this is that the more broadly an industry is defined, the more likely it is that a country will export some varieties of the differentiated product and import others. Thus, the T index must be used with caution. It can, nevertheless, be very useful in measuring differences in intra-industry trade in different industries and changes in intra-industry trade for the same industry over time (see Case Studies 6-5 and 6-6).

CASE STUDY 6-6 Intra-Industry Trade Indexes for G-20 Countries

Table 6.4 gives intra-industry trade indexes for the G-20 (the largest and most important advanced and emerging market economies plus the European Union as a whole) in 2006 at the SITC 3-digit and 5-digit levels. An index of 0.000 indicates no intra-industry trade, whereas an index of 1.0 indicates that the exports and imports of the country are equal in each product category. We would expect that for each country the intra-industry trade index at the 3-digit level be greater than that at the 5-digit level (i.e., the greater the degree of aggregation—for example, transportation equipment, which includes automotive products, trains, airplanes as compared simply to automobiles—the higher the intra-industry trade index). From the table, we can see that the index for developed countries is generally higher than for the other G-20.

TABLE 6.4. Intra-Industry Trade Indexes at the 3-Digit and 5-Digits Levels for the G-20 in 2006

Country	SITC-3 Digit	SITC-5 Digit	Country	SITC-3 Digit	SITC-5 Digit
France	0.600	0.424	Brazil	0.373	0.137
Canada	0.599	0.421	India	0.318	0.127
Germany	0.570	0.419	Argentina	0.313	0.156
United Kingdom	0.525	0.362	China	0.305	0.182
United States	0.503	0.317	South Africa	0.294	0.092
Italy	0.497	0.344	Indonesia	0.291	0.117
Mexico	0.478	0.334	Turkey	0.217	0.130
Thailand	0.449	0.252	Russia	0.146	0.047
Korea	0.412	0.240	Saudi Arabia	0.070	0.011
Japan	0.398	0.238	*Unweighted Average*	*0.387*	*0.229*

Source: M. Brülhart, "Global Intra-Industry Trade, 1962-2006," *The World Economy*, March 2009, pp. 401–459.

6.4c Formal Model of Intra-Industry Trade

Figure 6.2 presents a formal model of intra-industry trade. In Figure 6.2, D represents the demand curve faced by the firm for the differentiated products that it sells. Since many other firms sell similar products, the demand curve faced by the firm is fairly elastic (i.e., D has a small inclination). This means that a small price change leads to a large change in the firm's sales. The form or market organization where (as in this case) there are many firms selling a differentiated product and entry into or exit from the industry is easy is called monopolistic competition. Because the firm must lower the price *(P)* on all units of the commodity if it wants to increase sales, the marginal revenue curve of the firm *(MR)* is below the demand curve *(D)*, so that $MR < P$. For example, D shows that the firm can sell 2 units at $P =$ \$4.50 and have a total revenue of \$9 or sell 3 units at $P =$ \$4 and have a total revenue of \$12. Thus, the change in total revenue or $MR =$ \$3, compared with $P =$ \$4 for the third unit of the commodity sold.

By producing only one of a few varieties of the product, the firm also faces increasing returns to scale in production, so that its average cost curve *(AC)* is also downward sloping (i.e., AC declines as output increases). As a result, the firm's marginal cost curve *(MC)* is below the AC curve. The reason for this is that for AC to decline, MC must be smaller than AC. The best level of output for the firm is 3 units and is given by point E, where the MR and MC curves intersect (see Figure 6.2). At a smaller level of output, MR (i.e., the extra revenue) exceeds MC (i.e., the extra cost) and it pays for the firm to expand output.

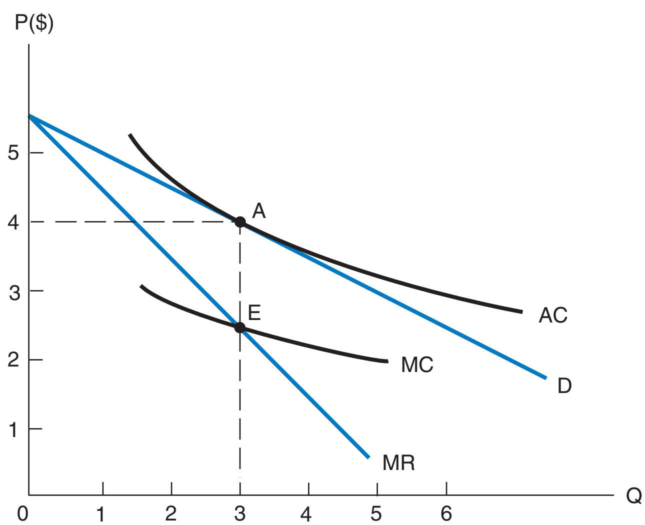

FIGURE 6.2. Production and Pricing under Monopolistic Competition.
D is the demand curve for the product sold by a firm, while *MR* is the corresponding marginal revenue curve. *D* is downward sloping because the product is differentiated. As a result, $MR < P$. The best level of output for the monopolistically competitive firm is 3 units and is given by point *E*, at which $MR = MC$. At $Q = 3$, $P = AC =$ \$4 (point *A*) and the firm breaks even (i.e., earns only a normal return on investment in the long run). *AC* is the average cost curve of the firm. *AC* is downward sloping because of economies of scale.

On the other hand, at an output greater than 3 units, $MR < MC$ and it pays for the firm to reduce output. Thus, the best level of output *(Q)* is 3 units. The firm will then charge the price of \$4, shown by point *A* on the *D* curve. Furthermore, since more firms are attracted to the industry in the long run whenever firms in the industry earn profits, the demand curve facing this firm *(D)* is tangent to its *AC* curve, so that $P = AC = \$4$ at $Q = 3$. This means that the firm breaks even (i.e., it earns only a normal return on investment in the long run).

We can now examine the relationship between inter-industry and intra-industry trade. To do this, suppose that Nation 1 has a relative abundance of labor and commodity X is labor intensive, while Nation 2 has a relative abundance of capital and commodity Y is capital intensive. If commodities X and Y are homogeneous, Nation 1 will export commodity X and import commodity Y, while Nation 2 will export commodity Y and import commodity X, as postulated by the Heckscher–Ohlin theory. This is inter-industry trade and reflects comparative advantage only. On the other hand, if there are different varieties of commodities X and Y (i.e., commodities X and Y are differentiated), Nation 1 will still be a net exporter of commodity X (this is inter-industry trade, which is based on comparative advantage), but it will also import some varieties of commodity X and export some varieties of commodity Y (this is intra-industry trade, which is based on product differentiation and economies of scale).

Similarly, while Nation 2 will still be a net exporter of commodity Y, it will also import some varieties of commodity Y and export some varieties of commodity X. The net exports of X and Y by Nations 1 and 2, respectively, reflect inter-industry trade, which is based on comparative advantage. On the other hand, the fact that Nation 1 also imports some varieties of commodity X and exports some varieties of commodity Y, while Nation 2 also imports some varieties of commodity Y and exports some varieties of commodity X (i.e., the fact that there is an interpenetration of each other's market in each product) reflects intra-industry trade, which is based on product differentiation and economies of scale. Thus, when products are homogeneous, we have only inter-industry trade. On the other hand, when products are differentiated, we have both inter- and intra-industry trade. The more similar nations are in factor endowments and technology, the smaller is the importance of inter-relative to intra-industry trade, and vice versa. Since industrial nations have become more similar in factor endowments and technology over time, the importance of intra-relative to inter-industry trade has increased. As pointed out earlier, however, a great deal of intra-industry trade is also based on differences in international factor endowments (when factors are defined less broadly and in a more disaggregated way).

6.4D Another Version of the Intra-Industry Trade Model

We now examine intra-industry trade from a different perspective with the aid of Figure 6.3. The horizontal axis in Figure 6.3 measures the number of firms *(N)* in a monopolistically competitive industry, while the vertical axis measures the product price *(P)* and the average or per unit cost of production *(AC)*. All firms sell at the same price even though their product is somewhat differentiated. This will be true if all firms in the monopolistically competitive industry are symmetric or face identical demand and cost functions or conditions.

In Figure 6.3, curve *P* shows the relationship between the number of firms in the industry and the product price. Curve *P* is negatively sloped, showing that the larger the number of firms in the industry the lower is the product price because competition is greater or more intense with more firms in the industry. For example, $P = \$4$ when $N = 200$ (see point

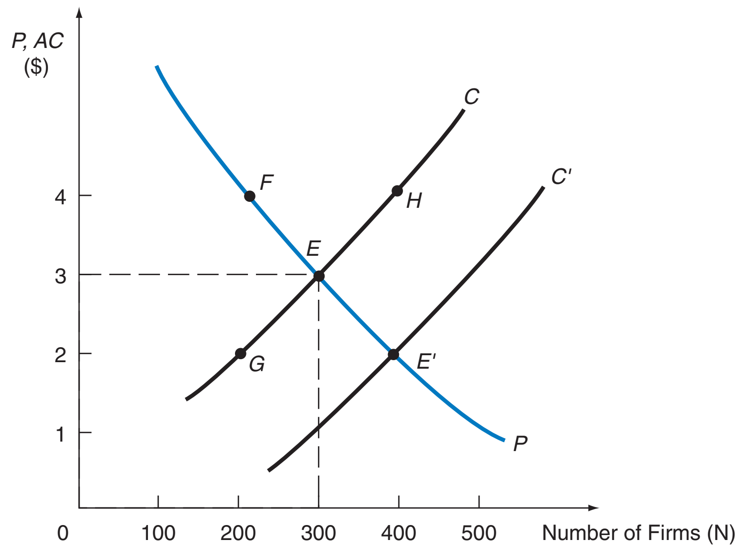

FIGURE 6.3. Monopolistic Competition and Intra-Industry Trade.
Curve *P* shows the negative relationship between the total number of firms in the industry *(N)* and product price *(P)*, while curve *C* shows the positive relationship between *N* and their average cost of production *(AC)* for a given level of industry output. Equilibrium is given by the intersection of the *P* and *C* curves at point *E*, where $P = AC = \$3$ and $N = 300$. Trade causes curve *C* to shift down to, say, curve *C′* and defines new equilibrium point *E′*, where $P = \$2$ and $N = 400$.

F in the figure), $P = \$3$ when $N = 300$ (point E), and $P = \$2$ when $N = 400$ (point E'). Curve C, on the other hand, shows the relationship between the number of firms in the industry and their average cost of production for a given level of industry output. Curve C is positively sloped, showing that the larger N is, the greater their AC is. The reason is that when more firms produce a given industry output, each firm's share of the industry output will be smaller, and so each firm will incur higher average costs of production. For example, $AC = \$2$ when $N = 200$ (point G in the figure), $AC = \$3$ when $N = 300$ (point E), and $AC = \$4$ when $N = 400$ (point H).

The intersection of curve P and curve C defines equilibrium point E, at which $P = AC = \$3$ and $N = 300$ and each firm breaks even (i.e., makes zero profits). With 200 firms, $P = \$4$ (point F), while $AC = \$2$ (point G). Since firms will then be earning profits, more firms will enter the industry until long-run equilibrium point E is reached. On the other hand, with $N = 400$, $P = \$2$ (point E'), while $AC = \$4$ (point H). Since now all firms incur losses, some firms will leave the industry until long-run equilibrium point E is reached.

By opening up or expanding international trade and thus becoming part of a much larger integrated world market, firms in each nation can specialize in the production of a smaller range of products and face lower average costs of production. Mutually beneficial trade can then take place even if nations are identical in factor endowments and technology. Consumers in each nation would benefit both from lower product prices and from the larger range of commodities. This is shown by the downward shift of curve C to curve C′ in Figure 6.3. Curve C shifts down to curve C' because an increase in market size or total industry sales increases the sales of each firm, for any given number of firms in the industry, and lowers the average production cost of each firm. The downward shift in curve C to curve C' leads to new long-run equilibrium point E', $P = AC = \$2$ and $N = 400$, as compared with original equilibrium point E (with $P = \$3$ and $AC = \$3$). Note that the increase in total industry sales does not affect the P curve (i.e., the P curve does not shift).

6.5 Trade Based on Dynamic Technological Differences

Apart from differences in the relative availability of labor, capital, and natural resources (stressed by the Heckscher–Ohlin theory) and the existence of economies of scale and product differentiation, dynamic changes in technology among nations can be a separate determinant of international trade. These are examined by the technological gap and product cycle models. Since time is involved in a fundamental way in both of these models, they can be regarded as dynamic extensions of the static H–O model.

6.5A Technological Gap and Product Cycle Models

According to the technological gap model sketched by *Posner* in 1961, a great deal of the trade among industrialized countries is based on the introduction of new products and new production processes. These give the innovating firm and nation a *temporary* monopoly in the world market. Such a temporary monopoly is often based on patents and copyrights, which are granted to stimulate the flow of inventions.

As the most technologically advanced nation, the United States exports a large number of new high-technology products. However, as foreign producers acquire the new technology, they eventually are able to conquer markets abroad, and even the U.S. market for the product, because of their lower labor costs. In the meantime, U.S. producers may have introduced still newer products and production processes and may be able to export these products based on the new technological gap established. A shortcoming of this model, however, is that it does not explain the size of technological gaps and does not explore the reason that technological gaps arise or exactly how they are eliminated over time.

A generalization and extension of the technological gap model is the product cycle model, which was fully developed by *Vernon* in 1966. According to this model, when a new product is introduced, it usually requires highly skilled labor to produce. As the product matures and acquires mass acceptance, it becomes standardized; it can then be produced by mass production techniques and less skilled labor. Therefore, comparative advantage in the product shifts from the advanced nation that originally introduced it to less advanced nations, where labor is relatively cheaper. This may be accompanied by foreign direct investments from the innovating nation to nations with cheaper labor.

Vernon also pointed out that high-income and labor-saving products are most likely to be introduced in rich nations because (1) the opportunities for doing so are greatest there, (2) the development of these new products requires proximity to markets so as to benefit from consumer feedback in modifying the product, and (3) there is a need to provide service. While the technological gap model emphasizes the time lag in the *imitation* process, the product cycle model stresses the *standardization* process. According to these models, the most highly industrialized economies are expected to export nonstandardized products embodying new and more advanced technologies and import products embodying old or less advanced technologies.

A classic example of the product cycle model is provided by the experience of U.S. and Japanese radio manufacturers since World War II. Immediately after the war, U.S. firms dominated the international market for radios, based on vacuum tubes developed in the United States. However, within a few years, Japan was able to capture a large share of the market by copying U.S. technology and utilizing cheaper labor. The United States recaptured technological leadership with the development of transistors. But, once again, in a few short years, Japan imitated the technology and was able to undersell the United States. Subsequently, the United States reacquired its ability to compete successfully with Japan by introducing printed circuits. It remains to be seen whether this latest technology will finally result in radios being labor or capital intensive and whether the United States will be able to stay in the market—or whether both the United States and Japan will eventually be displaced by still cheaper producers in such nations as Korea and Singapore.

In a 1967 study, *Gruber, Mehta, and Vernon* found a strong correlation between expenditures on research and development (R&D) and export performance. The authors took expenditures on research and development as a proxy for the *temporary* comparative advantage that firms and nations acquire in new products and new production processes. As such, these results tend to support both the technological gap model and the closely related product cycle model. We will see in Chapter 7 that the technological lead of the United States based on R&D has now almost disappeared with respect to Europe and Japan and has sharply narrowed with respect to some of the most advanced emerging markets such as China.

Note that trade in these models is originally based on new technology developed by the relatively abundant factors in industrialized nations (such as highly skilled labor and expenditures on research and development). Subsequently, through imitation and product standardization, less developed nations gain a comparative advantage based on their relatively cheaper labor. As such, trade can be said to be based on changes in relative factor abundance (technology) among nations over time. Therefore, the technological gap and product cycle models can be regarded as extensions of the basic H–O model into a technologically dynamic world, rather than as alternative trade models. In short, the product cycle model tries to explain *dynamic* comparative advantage for new products and new production processes, as opposed to the *basic* H–O model, which explains *static* comparative advantage. We return to this source of growth and change in comparative advantage over time in the next chapter.

6.5B Illustration of the Product Cycle Model

The product cycle model can be visualized with Figure 6.4, which identifies five different stages in the life cycle of a product (according to one version of the model) from the point of view of the innovating and the imitating country. In stage I, or new-product phase (referring to time *OA* on the horizontal axis), the product (at this time a specialty) is produced and consumed only in the innovating country. In stage II, or product-growth phase (time *AB*), production is perfected in the innovating country and increases rapidly to accommodate rising demand at home and abroad. At this stage, there is not yet any foreign production of the product, so that the innovating country has a monopoly in both the home and export markets.

In stage III, or product-maturity phase (time *BC*), the product becomes standardized, and the innovating firm may find it profitable to license other domestic and foreign firms to also manufacture the product. Thus, the imitating country starts producing the product

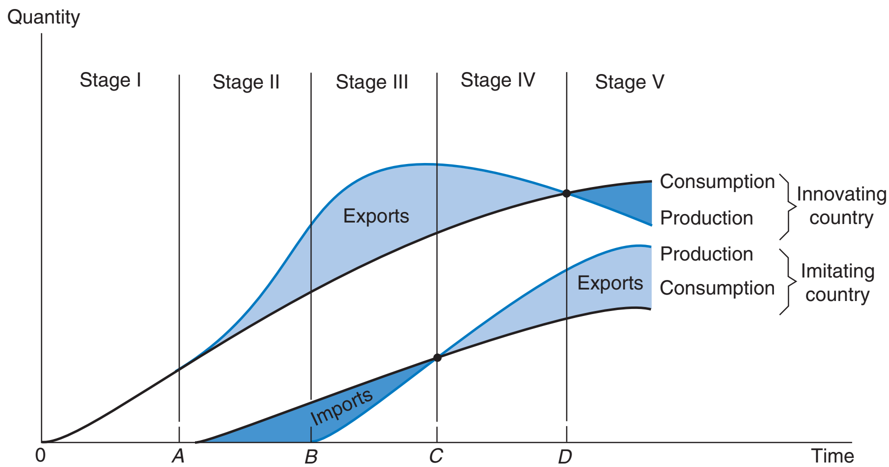

FIGURE 6.4. The Product Cycle Model.
In stage I (time *OA*), the product is produced and consumed only in the innovating country. In stage II *(AB)*, production is perfected in the innovating country and increases rapidly to accommodate rising demand at home and abroad. In stage III *(BC)*, the product becomes standardized and the imitating country starts producing the product for domestic consumption. In stage IV *(CD)*, the imitating country starts underselling the innovating country in third markets, and in stage V (past point *D*) in the latter's market as well.

for domestic consumption. In stage IV (time *CD*), the imitating country, facing lower labor and other costs now that the product has become standardized and no longer requires development and engineering skills, begins to undersell the innovating country in third markets, and production of the product in the innovating country declines. Brand competition now gives way to price competition. Finally, in stage V (i.e., past point *D*), the imitating country starts underselling the innovating country in the latter's market as well, and production of the product in the innovating country declines rapidly or collapses. Stages IV and V are often referred to as the product-decline stage. Technological diffusion, standardization, and lower costs abroad thus bring the end of the life cycle for the product. It is now time for the innovating country to concentrate attention on new technological innovations and to introduce new products.

Examples of products that seem to have gone through such product cycles are radios, stainless steel, razor blades, television sets, and semiconductors. In recent years, the diffusion lag of new technologies has shortened considerably, so that we have witnessed a time compression of the product life cycle. That is, the time from the introduction of a new product in the innovating country to the time when the imitating country displaces the innovating country in third markets and in the innovating country itself has become shorter and shorter. This may spell trouble for a country like the United States, which relies on new technologies and new products to remain internationally competitive. The benefits that the United States can reap from the new technologies and new products that it introduces are ever more quickly copied by other countries, especially Japan. In fact, Steven Jobs' Apple created the iPad but it outsourced all of its production! The old saying "The United States must run faster and faster simply to avoid falling behind" is very appropriate here. By turning out new products and technologies very rapidly, however, the United States is ranked as the most competitive economy in the world (see Case Study 6-7).

CASE STUDY 6-7 The United States as the Most Competitive Economy

Table 6.5 shows the 20 top-ranked nations in international competitiveness in 2011, as measured by the Switzerland-based Institute for Management Development (IMD). *International competitiveness* was defined as the ability of a country or company to generate more wealth for its people than its competitors in world markets. International competitiveness was calculated as the weighted average of more than 300 competitiveness criteria grouped into four large categories: (1) economic performance (macroeconomic evaluation of the domestic economy); (2) government performance (extent to which government policies are conducive to competitiveness); (3) business efficiency (extent to which enterprises perform in an innovative and profitable way); and (4) infrastructure (extent to which basic technological, scientific, and human resources meet the needs of business).

As Table 6.5 shows, Hong Kong occupies the top position, followed by the United States, Switzerland, Singapore, Sweden, and Canada. Germany is ninth and the United Kingdom is eighteenth. Of the G-7 countries, Japan is twenty-seventh, France is twenty-ninth, and Italy is fortieth.

TABLE 6.5. International Competitiveness Rankings in 2012

Rank	Country	Rank	Country
1	Hong Kong	11	Netherlands
2	United States	12	Luxembourg
3	Switzerland	13	Denmark
4	Singapore	14	Malaysia
5	Sweden	15	Australia
6	Canada	16	United Arab Rep.
7	Taiwan	17	Finland
8	Norway	18	United Kingdom
9	Germany	19	Israel
10	Qatar	20	Ireland

Source: Institute for Management Development, 2012.

6.6 Costs of Transportation, Environmental Standards, and International Trade

So far we have assumed that costs of transportation are zero (assumption 9 in Section 5.2). In this section, we relax this assumption. We will see that costs of transportation affect international trade directly by affecting the price of the traded commodity in the exporting and importing countries, and indirectly by affecting the international location of production and industry. We also examine these two effects as well as the effect of environmental pollution on the location of industry and international trade.

6.6A Costs of Transportation and Nontraded Commodities

Costs of transportation include freight charges, warehousing costs, costs of loading and unloading, insurance premiums, and interest charges while goods are in transit. We will use the term transport or logistics costs to include all the costs of transferring goods from one location (nation) to another.

A homogeneous good will be traded internationally only if the pretrade price difference in the two nations exceeds the cost of transporting the good from one nation to the other. Consideration of transport and logistics costs explains why most goods and services are not traded at all internationally. These are referred to as nontraded goods and services. They are the goods and services for which transport costs exceed price differences across nations. Thus, cement is not traded internationally except in border areas because of its high weight-to-value ratio. Similarly, the average person does not travel from New York to London simply to get a haircut.

In general, the price of nontraded commodities is determined by domestic demand and supply conditions, while the price of traded commodities is determined by world demand and supply conditions. The great reduction in transport costs that resulted from using refrigerated trucks and ships converted many nontraded into traded goods. For example, grapes and other fruits and vegetables found in many Boston, Chicago, New York, and Philadelphia stores during winter are shipped from South America. In the past, high transport costs and spoilage prevented this. Similarly, the development of containerized cargo shipping (i.e., the packing of goods in very large, standardized containers) greatly reduced the cost of handling and transporting goods, turning many previously nontraded commodities into traded ones.

There are two ways of analyzing transport costs. One is by general equilibrium analysis, which utilizes the nation's production frontiers or offer curves and expresses transport costs in terms of relative commodity prices. A more straightforward method is to analyze the absolute, or money, cost of transport with partial equilibrium analysis. This holds constant the rate of exchange between the two currencies, the level of income, and everything else in the two nations, except the amount produced, consumed, and traded of the commodity under consideration. This is shown in Figure 6.5.

In Figure 6.5, the common vertical axis measures the dollar price of commodity X in Nation 1 and in Nation 2. Increasing quantities of commodity X are measured by a movement to the right from the common origin (as usual) for Nation 2. Increasing quantities of commodity X for Nation 1 are instead measured by a movement to the left from the common origin. Note that Nation 1's demand curve for commodity X (D_X) is negatively inclined (slopes downward), while its supply curve of commodity X (S_X) is positively inclined, *as we move from the origin to the left*, as we should, for Nation 1.

In the absence of trade, Nation 1 produces and consumes 50X at the equilibrium price of $P_X = \$5$ (given by the intersection of D_X and S_X in Nation 1). Nation 2 produces and consumes 50X at $P_X = \$11$. With the opening of trade, Nation 1 will export commodity X to Nation 2. As it does, P_X rises in Nation 1 and falls in Nation 2. With a transport cost of $2 per unit, P_X in Nation 2 will exceed P_X in Nation 1 by $2. This cost will be shared by the two nations so as to balance trade. This occurs in Figure 6.5 when $P_X = \$7$ in Nation 1 and $P_X = \$9$ in Nation 2. At $P_X = \$7$, Nation 1 will produce 70X, consume domestically 30X, and export 40X to Nation 2. At $P_X = \$9$, Nation 2 will produce 30X, import 40X, and consume 70X.

Note that in the absence of transport costs, $P_X = \$8$ in both nations and 60X are traded. Thus, transport costs reduce the level of specialization in production and also the volume and gains from trade. Furthermore, since with transport costs the absolute (and relative) price of commodity X differs in the two nations, its factor price will not be completely equalized even if all the other assumptions of the H–O model hold.

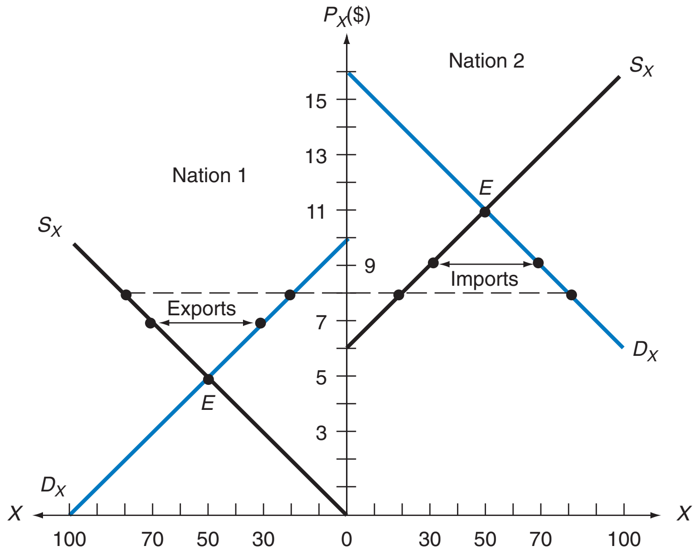

FIGURE 6.5. Partial Equilibrium Analysis of Transport Costs.
The common vertical axis measures the dollar price of commodity X in the two nations. A movement to the left from the common origin measures increasing quantities of commodity X for Nation 1. In the absence of trade, Nation 1 will produce and consume 50X at $P_X = \$5$. Nation 2 will produce and consume 50X at $P_X = \$11$. With transport costs of \$2 per unit, $P_X = \$7$ in Nation 1 and $P_X = \$9$ in Nation 2. At $P_X = \$7$, Nation 1 will produce 70X, consume 30X, and export 40X. At $P_X = \$9$, Nation 2 will produce 30X, import 40X, and consume 70X.

Finally, because of the way Figure 6.5 was drawn, the cost of transportation is shared equally by the two nations. In general, the more steeply inclined D_X and S_X are in Nation 1 relative to Nation 2, the greater is the share of transport costs paid by Nation 1. (The proof of this proposition and the general equilibrium analysis of transport costs are assigned as an end-of-chapter problem.)

6.6B Costs of Transportation and the Location of Industry

Transportation costs also affect international trade by influencing the location of production and industry. Industries can be classified as resource oriented, market oriented, or footloose.

Resource-oriented industries are those that tend to locate near the source of the raw materials used by the industry. For example, mining must obviously be located where the mineral deposits are located. More generally, resource-oriented industries are those for which the cost of transporting the raw materials used by the industry is substantially higher than for shipping the finished product to market. These are industries such as steel, basic chemicals, and aluminum, which process heavy and bulky raw materials into lighter finished products (i.e., involving substantial weight loss in processing).

Market-oriented industries, on the other hand, are those that locate near the markets for the products of the industry. These are the industries that produce goods that become heavier or more difficult to transport during the production process (i.e., that involve substantial weight gain in processing). An excellent example of this is provided by soft-drink companies, which ship their highly concentrated syrup to market, where water is added and bottling takes place (all very weight-gaining operations).

Footloose industries are those producing goods that face neither substantial weight gains nor losses during the production process. These industries tend to have high value-to-weight ratios and to be highly mobile, or footloose. They tend to locate where the availability of other inputs leads to the lowest overall manufacturing costs. An example is provided by U.S. computer companies, which ship U.S.-made components to Mexican border areas to be assembled by cheap Mexican labor, before being exported back to the United States to be packaged into the final product for sale on the U.S. market. Many governments offer preferential tax treatment to domestic and foreign investors to attract these footloose industries.

6.6c Environmental Standards, Industry Location, and International Trade

Industrial location and international trade are also affected by different environmental standards in different nations. Environmental standards refer to the levels of air pollution, water pollution, thermal (i.e., heat) pollution, and pollution resulting from garbage disposal that a nation allows. Environmental pollution results whenever the environment is used (abused) as a convenient and cheap dumping ground for all types of waste products arising from the production, consumption, or disposal of goods and services.

Environmental pollution can lead to serious trade problems because the price of traded goods and services often does not fully reflect social environmental costs. A nation with lower environmental standards can in effect use the environment as a resource endowment or as a factor of production in attracting polluting firms from abroad and achieving a comparative advantage in polluting goods and services. In fact, U.S. labor opposed NAFTA out of fear that many jobs would be lost in the United States as a result of U.S. firms migrating to Mexico to take advantage of much more lax environmental laws and lower cleanup costs. Environmental considerations were so strong that a side agreement on the environment had to be added to ensure the passage of NAFTA by the U.S. Congress. The High-Level Symposium on Trade and the Environment held in Geneva in March 1999 strongly recommended that trade agreements be subjected to environmental impact assessments.

A World Bank study by Low (1992) indicated that polluting or dirty industries and their exports have expanded faster than clean industries and their exports in poor developing countries than in rich developed countries. However, the study also found that as nations become richer, they voluntarily adopt more environmentally friendly approaches to economic development and become increasingly concerned about "sustainable development" (see Case Study 6-8).

In July 2001, a historic accord that set targets for industrialized countries to cut emission of greenhouse gases that contribute to global warming was signed as part of the implementation of the Kyoto Protocol on climate change signed in 1997. The United States refused to sign the agreement, calling its targets arbitrary and too costly to comply. At the UN conference on climate change held in Bali in December 2007, 190 nations (including the United States) signed an agreement to negotiate a new treaty to succeed the Kyoto protocol (due to expire in 2012), calling for the halving of the emission of heat-trapping gases by 2050.

CASE STUDY 6-8 Environmental Performance Index

Table 6.6 provides the ranking of 132 countries on the Environmental Performance Index (EPI) in 2012. EPI benchmarks the ability of nations to (1) reduce environmental stress to human health and (2) promote sound natural resource management, using 25 performance indicators grouped in six categories, which are then combined to create a single score.

Table 6.6 shows that Switzerland ranks first on EPI, followed by Latvia, Norway, Luxembourg, Costa Rica, France, Austria, Italy, the United Kingdom, and Sweden. The ranking of some of the other countries are: Germany (11), Japan (23), Brazil (30), Spain (32), Canada (37), South Korea (43), United States (49), Mexico (84), Russia (106), China (116), India (125)—all the way down to Iraq (132). In general, rich countries score high and poor countries low, with the poorest countries and petroleum-exporting countries scoring the lowest.

TABLE 6.6. Environmental Performance Index (EPI) Ranking in 2012

Countries with Highest Rank		Countries with Lowest Rank	
Rank	Country	Rank	Country
1.	Switzerland	123.	Lybia
2.	Latvia	124.	Bosnia and Herzegovina
3.	Norway	125.	India
4.	Luxembourg	126	Kuwait
5.	Costa Rica	127.	Yemen
6.	France	128.	South Africa
7.	Austria	129.	Kazakhstan
8.	Italy	130.	Uzbekistan
9.	United Kingdom	131.	Turkemistan
10.	Sweden	132.	Iraq

Source: 2012 Environmental Performance Index (http://epi.yale.edu/epi2012/rankings).

At the UN Climate Change Conference in Durban, South Africa, in December 2011, it was decided to extend the life of the Kyoto treaty and to negotiate a new pact by 2015 to take effect by 2020 that would include emission curbs also by developing countries, which now account for almost three-fifths of global emissions. The new pact is also to establish a $100 billion "green climate fund" through which developed nations help developing nations offset the impact of environmental change.

SUMMARY

1. Heckscher and Ohlin based comparative advantage on the difference in factor endowments among nations. This theory, however, leaves a significant portion of today's international trade unexplained. To fill this gap, we need new, complementary theories that base international trade on economies of scale, imperfect competition, and differences in technological changes among nations.

2. Relaxing most of the assumptions only modifies but does not invalidate the Heckscher–Ohlin theory. Relaxing the assumptions of constant economies of scale, perfect competition, and no differences in technological changes among nations, however, requires new, complementary trade theories to explain the significant portion of international trade that the H–O model leaves unexplained.

3. Even if two nations are identical in every respect, there is still a basis for mutually beneficial trade based on economies of scale. When each nation specializes in the production of one commodity, the combined total world output of both commodities will be greater than without specialization when economies of scale are present. With trade, each nation then shares in these gains. Outsourcing and offshoring are the source of new and significant international economies of scale but also lead to complaints that a significant number of high-paying jobs are transferred abroad.

4. A large portion of international trade today involves the exchange of differentiated products. Such intra-industry trade arises in order to take advantage of important economies of scale in production, which result when each firm or plant produces only one or a few styles or varieties of a product. Intra-industry trade can be measured by an index. With differentiated products, the firm faces a downward-sloping demand curve, produces in the downward-sloping portion of its average cost curve, and breaks even. The larger the number of firms in a monopolistically competitive industry, the lower the product price and the higher the average cost for a given level of output. With the enlargement of the market that trade brings about, the commodity price will then be lower and the number of firms greater. The more similar nations are in factor endowments, the greater is the importance of intra- relative to inter-industry trade.

5. According to the technological gap model, a firm exports a new product until imitators in other countries take away its market. In the meantime, the innovating firm will have introduced a new product or process. According to the related product cycle model, a product goes through five stages: the introduction of the product, expansion of production for export, standardization and beginning of production abroad through imitation, foreign imitators underselling the nation in third markets, and foreigners underselling the innovating firms in their home market as well.

6. With transportation costs, only those commodities whose pretrade price difference exceeds the cost of transporting them will be traded. When trade is in equilibrium, the relative price of traded commodities in the two nations will differ by the cost of transporting them. Transportation costs also affect international trade by affecting the location of production and industry. Industries can be classified as resource oriented, market oriented, or footloose. Environmental standards also affect the location of industry and international trade.

A LOOK AHEAD

The international trade theory discussed so far is, with few exceptions (such as the product cycle model), static in nature. That is, given the resource endowments, technology, and tastes of two nations, we proceeded to determine the comparative advantage of each nation and examine the resulting gains from trade. In the next chapter, we will analyze in detail the effect of changes in factor endowments, technology, and tastes on the comparative advantage of each nation, the volume of trade, the terms of trade, and the welfare of each nation. Although this does not make our trade theory dynamic, it does show that it can be extended to incorporate the effect of changes in underlying conditions through time.

KEY TERMS

Differentiated products, p. 163
Dynamic external economies, p. 184
Environmental standards, p. 178
External economies, p. 162
Footloose industries, p. 178
General equilibrium analysis, p. 176
Increasing returns to scale, p. 159
Infant industry argument, p. 184
International economies of scale, p. 161
Intra-industry trade, p. 163
Intra-industry trade index (T), p. 167
Learning curve, p. 184
Market-oriented industries, p. 177
Monopolistic competition, p. 169
Monopoly, p. 161

Nontraded goods and services, p. 176
Offshoring, p. 161
Oligopoly, p. 161
Outsourcing, p. 161
Partial equilibrium analysis, p. 176
Product cycle model, p. 172
Resource-oriented industries, p. 177
Technological gap model, p. 172
Transport or logistics costs, p. 176

QUESTIONS FOR REVIEW

1. What are two important limitations of the Heckscher–Ohlin theory?
2. Which assumptions of the Heckscher–Ohlin theory can be relaxed without invalidating the model?
3. The relaxation of which assumptions of the Heckscher–Ohlin theory require new, complementary trade theories to explain the significant portion of international trade not explained by the H–O model?
4. What is meant by economies of scale? How can they be the basis for international trade? What is meant by the "new international economies of scale"?
5. What is meant by product differentiation? Why does this result in imperfect competition? How can international trade be based on product differentiation?
6. How can intra-industry trade be measured? What are the shortcomings of such a measure?
7. What do we mean by monopolistic competition? Why do we use this model to examine intra-industry trade?
8. Why is it that the greater the number of firms is in a monopolistically competitive industry the lower the price is, but the higher the average cost of each firm is for a given level of output?
9. Why is the price lower and the number of firms greater with the larger market size with trade in a monopolistically competitive industry?
10. How can international trade take place according to the technological gap model? What criticisms are leveled against this model? What does the product cycle model postulate? What are the various stages in a product life cycle?
11. What is the relationship between the H–O theory and other trade theories?
12. What is the empirical relevance of the H–O theory and the new trade theories? What is the relationship between transportation costs and nontraded goods and services? How do transportation costs affect the H–O theorem? How do they affect the factor-price equalization theorem?
13. What is meant by resource-oriented industries? market-oriented industries? footloose industries? What determines the classification of the industry? How does this affect the pattern of international trade?
14. How do different environmental standards affect industry location and international trade?

PROBLEMS

***1.** Draw a figure similar to Figure 6.1, showing how mutually beneficial trade can take place between two nations based on economies of scale if the nations have identical production frontiers but different tastes.

2. Do the same as in Problem 1 for two nations that have equal tastes but different production frontiers.

3. Do the same as in Problem 1 for two nations with different production frontiers and tastes.

4. Find the degree of intra-industry trade if exports and imports are, respectively

(a) 1,000 and 1,000

(b) 1,000 and 750

(c) 1,000 and 500

(d) 1,000 and 25

(e) 1,000 and 0

5. Do the same as in Problem 4, but interchange the values of exports and imports.

***6.** Using the same *AC* and *MC* curves as in Figure 6.2, draw a figure similar to Figure 6.2 but showing that the firm can earn a profit before other firms imitate its product and reduce its market share.

7. **(a)** In what way does monopolistic competition resemble monopoly?

(b) How is it different?

(c) Why is the difference between monopolistic competition and monopoly important for consumer welfare in our intra-industry trade model?

8. How do the demand curves facing a perfectly competitive firm, a monopolistically competitive firm, and a monopolist firm differ from one another? Why?

9. What would happen if the *C* curve had shifted down only half as much as curve C' in Figure 6.3?

10. Draw a figure showing the exports of the innovating and of the imitating country during the various stages of the product cycle.

11. Indicate how increased pirating or production and sale of counterfeit American goods without paying royalties by foreign producers might affect the product cycle in the United States.

12. Show how transportation costs can be analyzed with production frontiers. (*Hint*: Relative commodity prices with trade will differ by the cost of transportation.)

13. Do the same as in Problem 12 with offer curves.

***14.** Draw a figure similar to Figure 6.5, showing that transport costs fall more heavily on the nation with the steeper demand and supply curves for the traded commodity.

*= Answer is provided at www.wiley.com/college/salvatore.

APPENDIX

In this appendix, we examine external economies and their effect on the pattern of trade in Section A6.1 and then go on to deal with dynamic external economies and learning curves in Section A6.2.

A6.1 External Economies and the Pattern of Trade

In Section 6.3, we defined *external economies* as the reduction in each firm's average costs of production as the *industry's* output expands. This is to be distinguished from internal economies or increasing returns to scale, which refer to the reduction in a firm's average cost of production as the *firm's* output expands. External economies arise because a larger and more geographically concentrated industry is likely to provide more specialized labor and other services, thus leading to higher productivity and lower average costs for all the firms in the industry. This is the reason that so many computer companies are clustered in California's Silicon Valley and financial institutions and banks are concentrated in New York City.

Since external economies depend on the expansion in the number of firms in the industry rather than on the size of individual firms, they are entirely consistent with perfect competition. That is, with external economies, firms enjoy lower average costs of production because the industry rather than the firm is very large. With economies or increasing returns to scale, on the other hand, the expansion in the size of one or a few firms in the industry leads to monopoly or oligopoly, and hence to the breakdown of perfect competition.

External economies also affect the pattern of international trade. Specifically, the nation where a given industry is larger is likely to have lower average costs of production (i.e., greater external economies) and thus to be the exporter of the commodity. The nation in which an industry is first established or becomes larger may be a purely historical accident. Once an industry is established or has grown larger in one nation than in another, however, the first nation is likely to gain an even greater cost advantage over the second nation over time. That is, its advantage becomes cumulative over time. Even if Nation 2 could then have become the lower-cost producer (if its industry output were to grow as large as that of Nation 1), with Nation 1 already producing and exporting the commodity, this may not be possible. Thus, we cannot determine the pattern of trade in the presence of significant external economies. This is shown in Figure 6.6.

In Figure 6.6, D_w refers to the world demand curve for a commodity. The commodity could be produced either by Nation 1 (with average cost curve AC_1) or by Nation 2 (with average cost curve AC_2). The average cost of producing the commodity is lower for larger *industry* outputs in each nation because of external economies. Competition among the firms

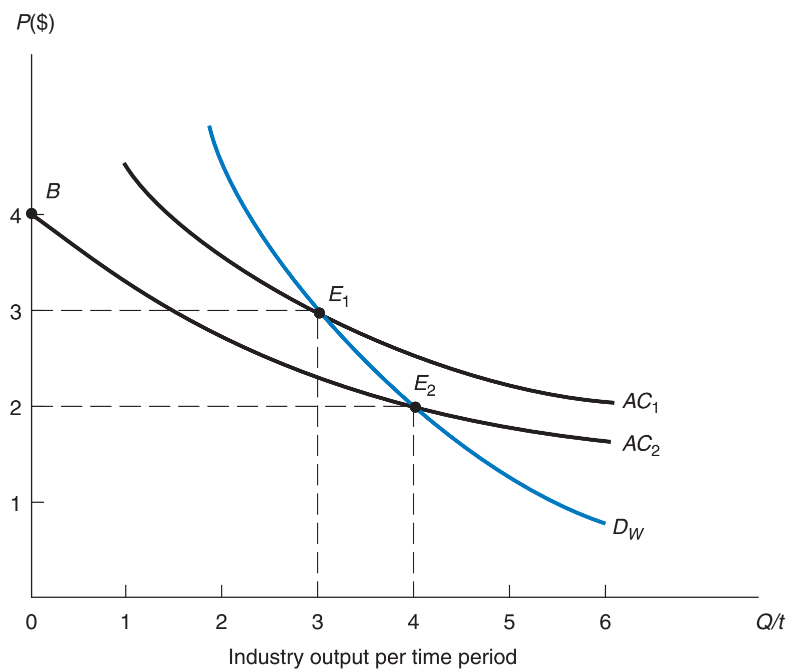

FIGURE 6.6. External Economies and Specialization.
D_w refers to the world demand curve for a commodity. The AC_1 and AC_2 curves are downward sloping because of external economies. If Nation 1 were the sole supplier of the commodity, it would produce three units of the commodity at $AC = P = \$3$ (point E_1). On the other hand, if Nation 2 were the sole supplier, it would produce four units of the commodity at $AC = P = \$2$ (point E_2). $P = AC$ in either case because of perfect competition. If the industry did not exist in Nation 2, Nation 2 would not start producing the commodity because its average cost at the beginning would be higher (point B) than in Nation 1 when the latter is already in the market (point E_1).

in the industry would also lead to a price *(P)* equal to the average cost of production *(AC)* in either country.

Suppose that because of some historical accident or other reason, the industry is already established in Nation 1 but not in Nation 2. Then Nation 1 would supply the world market by producing three units of the commodity at $AC = P = \$3$ (point E_1 in the figure). Nation 2, however, could supply four units of the commodity at $AC = P = \$2$ (point E_2 in the figure). With Nation 1 already in the market, however, Nation 2 cannot enter the market. Specifically, Nation 2 would face $AC = \$4$ (point B in the figure) to begin producing the commodity. Since this is higher than the price at which Nation 1 already supplies the commodity to the world market, Nation 2 will not produce the commodity. Thus, with large external economies, the pattern of trade cannot be determined on the basis of lower actual or potential average costs.

Problem Draw a figure showing external economies for a single firm.

A6.2 Dynamic External Economies and Specialization

As firms gain experience in production, they often make improvements in their product or in their production techniques. As other firms then imitate the innovating firms, average costs of production fall for the entire industry. This decline in the average cost of production as the *cumulative* output of the industry increases and firms accumulate knowledge over time is called dynamic external economies. While the simple external economies discussed before arise when the industry output *per time period* increases, dynamic external economies arise as the cumulative output of the industry increases and firms accumulate knowledge *over time*. For example, it might take 1,000 hours to assemble the 100th aircraft, but only 700 hours to assemble the 200th aircraft because as managers and workers gain production experience they become more efficient. Real-world experience shows that average costs decline by 20 to 30 percent for each doubling of cumulative output for many industries.

Dynamic external economies can be shown graphically by learning curves. A learning curve shows the degree by which average costs of production decline as the cumulative industry output increases over time. For example, Figure 6.7 shows that the average cost of production for the industry in Nation 1 is \$2.50 when output is 200 units (point F on L_1), \$2.00 when the cumulative output doubles to 400 units (point C), and \$1.60 when cumulative output has doubled again to 800 units (point H).

Figure 6.7 also shows that Nation 2 could produce 400 units of the product at a cost of \$1.50 per unit (point G on L_2), but since it faces the higher startup cost of \$3 per unit (point J), it may not enter the market. The only way for Nation 2 to enter the market is for its government to provide temporary trade protection or subsidies to the industry while it grows and accumulates knowledge. This is called the infant industry argument. It is extremely difficult, however, to pick winners (i.e., to pick industries that will grow into adulthood and become able to compete freely in the world market in a reasonable period of time). More will be said on this when we discuss trade policies in Section 9.4B.

Problem The equation of the learning curve can be expressed as $AC = aQ^b$. Explain the meaning of each parameter and whether it needs to assume a positive or negative value to obtain a learning curve.

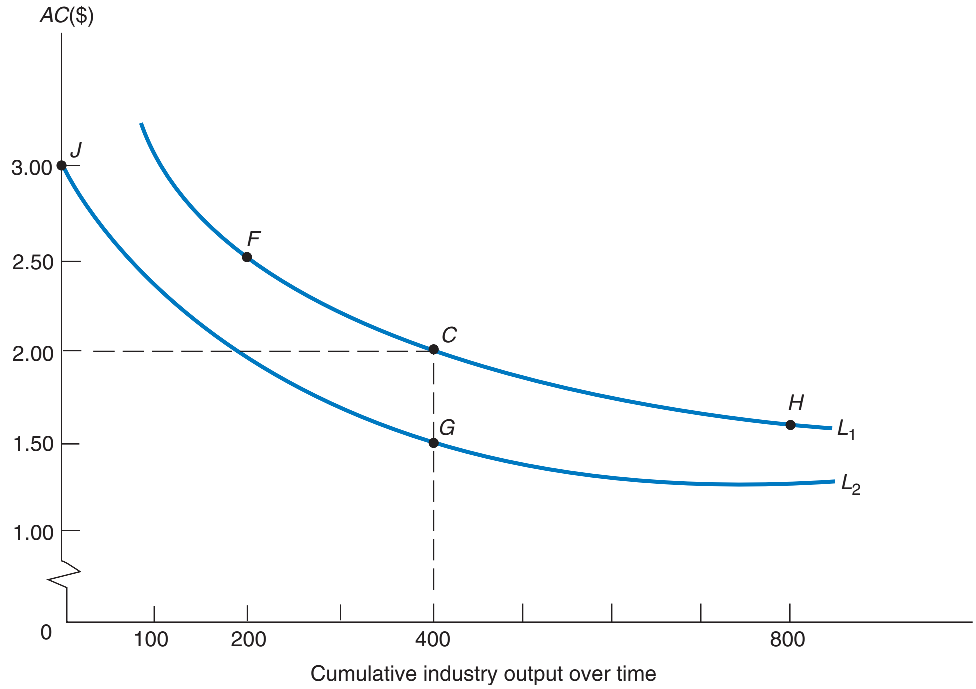

FIGURE 6.7. The Learning Curve and Specialization.
The figure shows that the average cost of production for the industry in Nation 1 is $2.50 when output is 200 units (point *F* on L_1), $2.00 when the cumulative output doubles to 400 units (point *C*), and $1.60 when cumulative output has doubled again to 800 units (point *H*). The figure also shows that Nation 2 could produce 400 units of the product at a cost of $1.50 per unit (point *G* on L_2), but since it faces the higher startup cost of $3 per unit (point *J*), it may not enter the market.

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