Having clarified the meaning of factor intensity and factor abundance, we are now ready to present the Heckscher–Ohlin theory.

5.4 Factor Endowments and the Heckscher–Ohlin Theory

In 1919, *Eli Heckscher*, a Swedish economist, published an article titled "The Effect of Foreign Trade on the Distribution of Income," in which he presented the outline of what was to become the "modern theory of international trade." The article went largely unnoticed for over ten years until *Bertil Ohlin*, another Swedish economist and former student of Heckscher, picked it up, built on it, clarified it, and in 1933 published his famous book *Interregional and International Trade*.

We will discuss only Ohlin's work, since it incorporates all that Heckscher had said in his article and much more. However, since the essence of the model was first introduced by Heckscher, due credit is given to him by calling the theory the Heckscher–Ohlin theory. Ohlin, for his part, shared (with James Meade) the 1977 Nobel prize in economics for his work in international trade.

The Heckscher–Ohlin (H–O) theory can be presented in a nutshell in the form of two theorems: the so-called *H–O theorem* (which deals with and predicts the pattern of trade) and the *factor–price equalization theorem* (which deals with the effect of international trade on factor prices). The factor–price equalization theorem will be discussed in Section 5.5. In this section, we present and discuss the H–O theorem. We begin with a statement of the theorem and briefly explain its meaning. Then we examine the general equilibrium nature of the H–O theory, and finally we give a geometrical interpretation of the model.

5.4A The Heckscher–Ohlin Theorem

Starting with the assumptions presented in Section 5.2, we can state the Heckscher–Ohlin theorem as follows: *A nation will export the commodity whose production requires the intensive use of the nation's relatively abundant and cheap factor and import the commodity whose production requires the intensive use of the nation's relatively scarce and expensive factor*. In short, the relatively labor-rich nation exports the relatively labor-intensive commodity and imports the relatively capital-intensive commodity.

In terms of our previous discussion, this means that Nation 1 exports commodity X because commodity X is the L-intensive commodity and L is the relatively abundant and cheap factor in Nation 1. Conversely, Nation 2 exports commodity Y because commodity Y is the K-intensive commodity and K is the relatively abundant and cheap factor in Nation 2 (i.e., r/w is lower in Nation 2 than in Nation 1).

Of all the possible reasons for differences in relative commodity prices and comparative advantage among nations, the H–O theorem isolates the difference in relative factor abundance, or *factor endowments*, among nations as the basic cause or determinant of comparative advantage and international trade. For this reason, the H–O model is often referred to as the factor-proportions or factor-endowment theory. That is, each nation specializes in the production and export of the commodity intensive in its relatively abundant and cheap factor and imports the commodity intensive in its relatively scarce and expensive factor.

Thus, the H–O theorem *explains* comparative advantage rather than assuming it (as was the case for classical economists). In other words, the H–O theorem postulates that the difference in relative factor abundance and prices is the *cause* of the pretrade difference in relative commodity prices between two nations. This difference in *relative* factor and *relative* commodity prices is then translated into a difference in *absolute* factor and commodity prices between the two nations (as outlined in Section 2.4D). It is this difference in absolute commodity prices in the two nations that is the *immediate* cause of trade.

5.4B General Equilibrium Framework of the Heckscher–Ohlin Theory

The general equilibrium nature of the H–O theory can be visualized and summarized with the use of Figure 5.3. Starting at the lower right-hand corner of the diagram, we see that tastes and the distribution in the ownership of factors of production (i.e., the distribution of income) together determine the demand for commodities. The demand for commodities determines the derived demand for the factors required to produce them. The demand for factors of production, together with the supply of the factors, determines the price of factors of production under perfect competition. The price of factors of production, together with technology, determines the price of final commodities. The difference in relative commodity prices between nations determines comparative advantage and the pattern of trade (i.e., which nation exports which commodity).

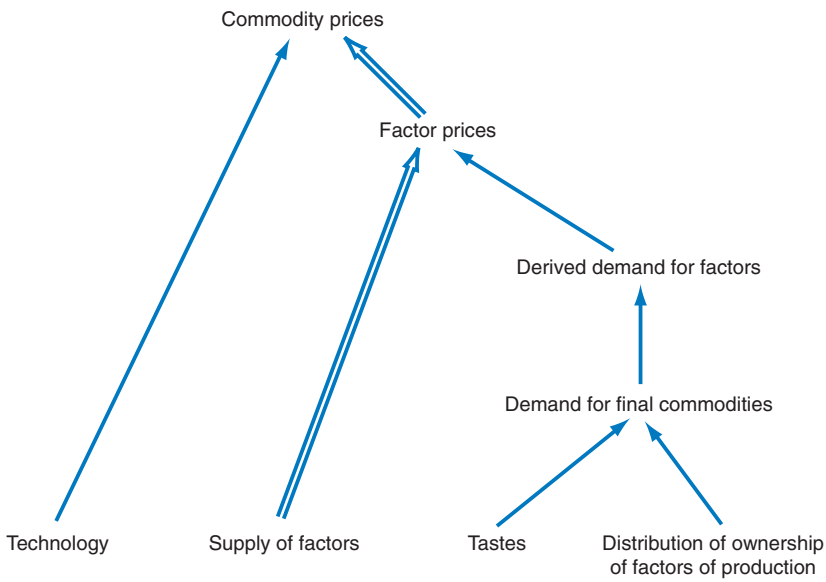

FIGURE 5.3. General Equilibrium Framework of the Heckscher–Ohlin Theory.
Beginning at the lower right-hand corner of the diagram, we see that the distribution of ownership of factors of production or income and tastes determines the demand for commodities. The demand for factors of production is then derived from the demand for final commodities. The demand for and supply of factors determine the price of factors. The price of factors and technology determine the price of final commodities. The difference in relative commodity prices among nations then determines comparative advantage and the pattern of trade.

Figure 5.3 shows clearly how all economic forces jointly determine the price of final commodities. This is what is meant when we say that the H–O model is a general equilibrium model.

However, out of all these forces working together, the H–O theorem isolates the difference in the *physical* availability or supply of factors of production among nations (in the face of equal tastes and technology) to explain the difference in relative commodity prices and trade among nations. Specifically, Ohlin assumed equal tastes (and income distribution) among nations. This gave rise to similar demands for final commodities and factors of production in different nations. Thus, it is the difference in the supply of the various factors of production in different nations that is the cause of different relative factor prices in different nations. Finally, the same technology but different factor prices lead to different relative commodity prices and trade among nations. Thus, the difference in the relative supply of factors leading to the difference in relative factor prices and commodity prices is shown by the double lines in Figure 5.3.

Note that the H–O model does not require that tastes, distribution of income, and technology be exactly the same in the two nations for these results to follow. It requires only that they be broadly similar. The assumptions of equal tastes, distribution of income, and technology do simplify the exposition and graphical illustration of the theory. They will be relaxed in Section 6.2.

5.4c Illustration of the Heckscher–Ohlin Theory

The H–O theory is illustrated in Figure 5.4. The left panel of the figure shows the production frontiers of Nation 1 and Nation 2, as in Figure 5.2. As indicated in Section 5.3c, Nation 1's production frontier is skewed along the X-axis because commodity X is the *L*-intensive

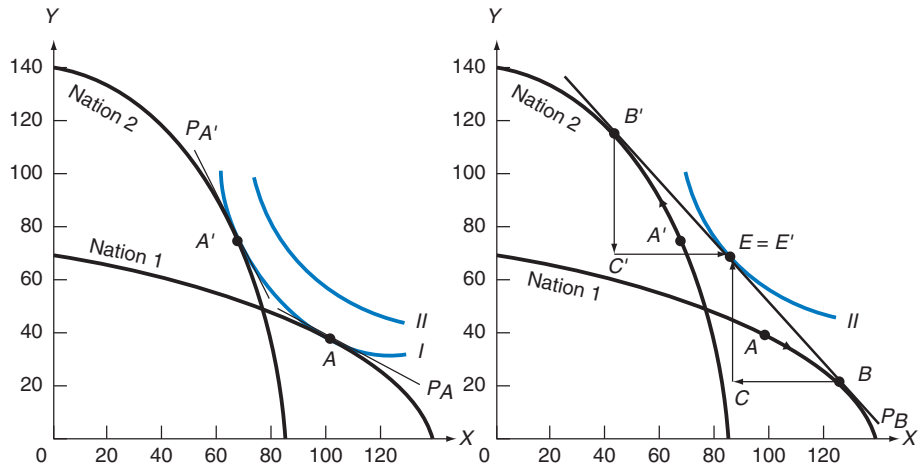

FIGURE 5.4. The Heckscher—Ohlin Model.
Indifference curve *I* is common to both nations because of the assumption of equal tastes. Indifference curve *I* is tangent to the production frontier of Nation 1 at point *A* and tangent to the production frontier of Nation 2 at *A'*. This defines the no-trade equilibrium-relative commodity price of P_A in Nation 1 and $P_{A'}$ in Nation 2 (see the left panel). Since $P_A < P_{A'}$, Nation 1 has a comparative advantage in commodity X and Nation 2 in commodity Y. With trade (see the right panel) Nation 1 produces at point *B* and by exchanging X for Y reaches point *E* in consumption (see trade triangle *BCE*). Nation 2 produces at *B'* and by exchanging Y for X reaches point *E'* (which coincides with *E*). Both nations gain from trade because they consume on higher indifference curve *II*.

commodity, Nation 1 is the *L*-abundant nation, and both nations use the same technology. Furthermore, since the two nations have equal tastes, they face the same indifference map. Indifference curve I (which is common for both nations) is tangent to Nation 1's production frontier at point A and to Nation 2's production frontier at A'. Indifference curve I is the highest indifference curve that Nation 1 and Nation 2 can reach in isolation, and points A and A' represent their equilibrium points of production and consumption in the absence of trade. Note that although we assume that the two nations have identical tastes (indifference map), the two nations need not be on the *same* indifference curve in isolation and end up on the same indifference map with trade. We only did so in order to simplify the figure.

The tangency of indifference curve I at points A and A' defines the no-trade, or autarky, equilibrium-relative commodity prices of P_A in Nation 1 and $P_{A'}$ in Nation 2 (see the figure). Since $P_A < P_{A'}$, Nation 1 has a comparative advantage in commodity X, and Nation 2 has a comparative advantage in commodity Y.

The right panel shows that with trade Nation 1 specializes in the production of commodity X, and Nation 2 specializes in the production of commodity Y (see the direction of the arrows on the production frontiers of the two nations). Specialization in production proceeds until Nation 1 has reached point B and Nation 2 has reached point B', where the transformation curves of the two nations are tangent to the common relative price line P_B. Nation 1 will then export commodity X in exchange for commodity Y and consume at point E on indifference curve II (see trade triangle BCE). On the contrary, Nation 2 will export Y for X and consume at point E', which coincides with point E (see trade triangle $B'C'E'$).

Note that Nation 1's exports of commodity X equal Nation 2's imports of commodity X (i.e., $BC = C'E'$). Similarly, Nation 2's exports of commodity Y equal Nation 1's imports of commodity Y (i.e., $B'C' = CE$). At $P_X/P_Y > P_B$, Nation 1 wants to export more of commodity X than Nation 2 wants to import at this high relative price of X, and P_X/P_Y falls toward P_B. On the contrary, at $P_X/P_Y < P_B$, Nation 1 wants to export less of commodity X than Nation 2 wants to import at this low relative price of X, and P_X/P_Y rises toward P_B. This tendency of P_X/P_Y could also be explained in terms of commodity Y.

Also to be noted is that point E involves more of Y but less of X than point A. Nevertheless, Nation 1 gains from trade because point E is on higher indifference curve II. Similarly, even though point E' involves more X but less Y than point A', Nation 2 is also better off because point E' is on higher indifference curve II. This pattern of specialization in production and trade and consumption will remain the same until there is a change in the underlying demand or supply conditions in commodity and factor markets in either or both nations.

It is now instructive briefly to compare Figure 5.4 with Figure 3.4. In Figure 3.4, the difference in the production frontiers of the two nations is reinforced by their difference in tastes, thus making the autarky-relative commodity prices in the two nations differ even more than in Figure 5.4. On the other hand, the tastes of the two nations could be different in such a way as to make mutually beneficial trade impossible. This would occur if the different indifference curves in the two nations were tangent to their respective and different production frontiers in such a way as to result in equal autarky-relative commodity prices in the two nations. This is assigned as end-of-chapter Problem 4, with the answer on the website.

Note also that the H–O theory does not require identical tastes (i.e., equal indifference curves) in the two nations. It only requires that if tastes differ, they do not differ sufficiently to neutralize the tendency of different factor endowments and production possibility curves from leading to different relative commodity prices and comparative advantage in the two nations.

Thus, in a sense, Figure 3.4 can be regarded as a more general illustration of the H–O model than Figure 5.4. Case Study 5-3 identifies the factor intensity of various industries and then Case Study 5-4 examines whether the patterns of trade of some of the leading developed and developing countries conforms to their factor endowments, as predicted by the H–O theory.

CASE STUDY 5-3 Classification of Major Product Categories in Terms of Factor Intensity

Table 5.3 gives the approximate factor intensity of the major product categories entering into international trade. It must be pointed out, however, that in this age of globalization and outsourcing of parts and components from abroad, the overall average factor intensity of a product may be different from that of some of its parts and components.

TABLE 5.3. Factor Intensity of Major Product Categories

Arable Land and Other Natural Resource-Intensive Products:
Agricultural products (food and raw materials)
Fuels and mining products (ores and other minerals, fuels, and nonferrous metals)

Capital-Intensive Products:
Iron and steel
Agricultural chemicals
Automotive products (automotive vehicles, parts, and engines)

R&D Scientists and Other Highly Skilled Labor-Intensive Products:
Chemicals (pharmaceuticals and other chemicals, excluding agricultural)
Office and telecommunications equipment
Civilian aircraft, engines, and parts
Machinery (power generating, nonelectrical, and electrical machinery)
Scientific and controlling instruments

Unskilled Labor-Intensive Products
Textiles
Clothing and footwear
Personal and household goods

Source: World Trade Organizations, *International Trade Statistics,* (Geneva: WTO, 2008); and J. Romalis, ''Factor Proportions and the Structure Commodity of Trade,'' *American Economic Review,* March 2004, pp. 67–97.

CASE STUDY 5-4 The Factor Intensity of Trade of Various Countries

We now look at trade data for the year 2006 to determine the factor intensities of the net exports of the various countries examined in Case Study 5-1 to see if their trade broadly corresponded to their relative factor endowments.

United States: In 2006, the United States had a net export surplus in products intensive in R&D and other highly skilled labor (such as chemicals other than pharmaceuticals, aircrafts, integrated circuits, power-generating machinery, and scientific and controlling instruments), and a net import surplus in some natural resource products (such as fuels) and products intensive in unskilled labor (such as textiles, clothing, and personal and household goods). These correspond to the broad relative factor endowments of the

(continued)

CASE STUDY 5-4 Continued

United States and conform to the predictions of the H–O theory. On the other hand, the United States had a net trade deficit in other products intensive in R&D and highly skilled labor, such as pharmaceuticals, machinery (other than power generating machinery), and office and telecommunications equipment, and a net exporter of agricultural products, when we would have expected the opposite. The United States was also a large net importer of some capital-intensive products (such as iron and steel, and automotive products), in which we would have expected its trade to be more or less balanced.

Japan: Japan had a large net export surplus in capital-intensive products and products intensive in R&D and other highly skilled labor, and a very large net import surplus in products intensive in natural resources and unskilled labor—as expected from Japan's relative factor endowments. Japan also had large net imports surplus of commercial aircrafts.

European Union: As predicted by its relative factor abundance, the European Union (EU-27) had a net export surplus in capital-intensive products and in products intensive in R&D and other highly skilled labor, and a net import surplus in agricultural products, fuels and mining products, textiles and clothing, and personal and household goods. But the EU had also a large net import surplus in office and telecom equipment, which is not in conformity with its relative abundance of R&D and other highly skilled labor.

Canada: Canada's trade was dominated by a very large net export surplus in agricultural products and fuels and mining products, and a large net import surplus of products intensive in unskilled labor as predicted by its relative factor endowments. Contrary to its relative abundance, however, Canada had a net import surplus in almost all other capital and skill-intensive products, except for automotive products (which was mostly in balance).

China: As predicted by its relative factor endowments, China had a large import surplus in agricultural, fuel, and mining products, and a large export surplus in iron and steel, in transport equipment other than automotive, and in office and telecom equipment, electrical machinery, textiles, clothing, and personal and household goods. Contrary to its relative factor endowments, however, China had net import surplus in chemicals other than pharmaceuticals, integrated circuits, automotive products, and power-generating and nonelectrical machinery.

Other Countries: As for the other countries, the trade of India, Russia, Brazil, Korea, and Mexico reflected to a large extent their relative factor endowments, but with some major exceptions.

In summary, we can say that a great deal of the trade of most of the largest developed and developing countries took place as predicted by the factor endowment (H–O) theory, but there were some important exceptions. More rigorous tests of the H–O theory are discussed in Section 5.6. Changes in comparative advantage over time are examined in Chapter 7.

Source: World Trade Organization, *International Trade Statistics*, Geneva, 2008.

5.5 Factor–Price Equalization and Income Distribution

In this section, we examine the *factor–price equalization theorem*, which is really a corollary, since it follows directly from the H–O theorem and holds only if the H–O theorem holds. It was *Paul Samuelson* (1970 Nobel prize in economics) who rigorously proved this