Chapter 5 Factor Endowments and the Heckscher-Ohlin Theory

"Land is still so cheap, and, consequently, labor so dear among them, that they can import from the mother country, almost all the more refined or more advanced manufactures cheaper than they could make them for themselves."

Adam Smith (on the English colonies), Wealth of Nations, Book IV, Chapter VII.

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II. Chapter Summary and Review

This chapter introduces and discusses the **Heckscher-Ohlin** (H-O) **theory** of trade and its implications. The H-O theory is also known as the **factor-proportions theory** or **factor-endowment theory**. A principal result of the H-O theory is the Heckscher-Ohlin Theorem which states the following.

A nation will export the product that uses its most abundant factor intensively.

This result will be explained in detail in developing the H-O theory. Both the Ricardian and opportunity-cost models demonstrate that comparative advantage is the basis of trade, but neither adequately explains the source of a country's comparative advantage. The H-O model explains comparative advantage in terms of the <u>factor abundance of nations</u> and the <u>factor intensity</u> <u>of commodities</u>.

Factor abundance is the resource richness of nations. In a two-factor model, where the factors are capital and labor, the factor abundance of one nation is defined by the *relative* endowment of capital to labor in the nation *relative* to another nation or nations.

The relative aspect of factor abundance is important. For example, the U.S. has more of both labor and capital than Mexico, but the quantity of capital advantage in the U.S. over Mexico is greater than the quantity of labor advantage in the U.S. over Mexico. The U.S., therefore, is capital abundant and Mexico is labor abundant. Letting K measure the quantity of capital and L the quantity of labor, $(K/L)_{US}>(K/L)_{MEX}$, or the amount of capital per laborer in the U.S. exceeds that of Mexico. (Verify that it is possible for L_{US} to be greater than L_{MEX} and $(K/L)_{US}>(K/L)_{MEX}$). Now invert the ratios, which reverses the inequality, so $(L/K)_{US}<(L/K)_{MEX}$, which says that Mexico is labor abundant relative to the U.S. If one country is capital rich (more capital relative to labor) then the other is labor rich (more labor relative to capital).

Factor abundance can also be measured by **relative factor prices**. If Mexico is abundant in labor then, *ceteris paribus*, labor will be relatively cheaper in Mexico than in the U.S. Thus, $(w/r)_{M} < (w/r)_{US}$, where w is the wage rate and r is the cost of capital, usually taken to be the interest rate. If $(w/r)_{M} < (w/r)_{US}$ the $(r/w)_{M} > (r/w)_{US}$, so capital is relatively cheaper in the US.

Note that it is possible for a nation with labor abundance to have a high relative wage rate if the wage has been pushed up by a high demand for products made with labor. The H-O model does, however, assumes that product demand is similar across nations, so the quantity definition of abundance will align with the factor-price definition of abundance. If, however, demand does differ across nations and the quantity definition does not align with the factor-price definition, then abundance should be defined using relative factor prices. (The term "relative factor price" refers to either w/r or r/w. The ratio w/r is the relative wage and r/w is the relative price of capital.)

Factor intensity refers to the *relative* amounts of capital and labor used in producing a good. Fig. 5.1 shows the use of capital and labor in the production of two commodities. The amount of capital per laborer in the production of a good is called the **capital-labor ratio**. For good Y, 2 units of capital are used with 10 units of capital, so the capital-labor ratio is 2/10, or 1/5. If the capital-labor ratio is constant, then a straight line, as in Fig. 5.1, shows capital-labor usage at different levels of K and L usage.



In Fig. 5.1, good Y is capital intensive because the amount of capital per laborer (1/2) in the production of Y is higher than the amount of capital per laborer in the production of X (1/5). This can be written as $(K/L)_Y>(K/L)_X$. Factor intensity is measured in relative terms so if good Y is a **capital-intensive commodity**, then good X must be a **labor-intensive commodity** because if $(K/L)_Y>(K/L)_X$, then $(L/K)_Y<(L/K)_X$.

The H-O model assumes that a good that is capital intensive in one nation is also capital intensive in another nation, although the capital-labor ratios could differ across nations as each nation adjusts factor usage to different factor prices. (See Fig. 5.1 in Chapter 5 of the *International Economics*.)

The H-O theory states that a commodity will be produced more cheaply by the nation that has a lot of the input that the commodity uses more of in production. If a commodity uses a relatively large amount of capital, then nations with abundant capital will have a comparative advantage in that commodity. *A nation will export the product that uses its most abundant factor intensively.* This implies that the nation will import that product that intensively uses the nation's scarce factor.

The effect of abundance and factor intensity on the ppf of two nations is shown in Fig.5.2. It is assumed that Nation 1 is labor abundant, so by definition, Nation 2 is capital abundant. Good Y is assumed to be capital intensive in both nations, so by definition, Good X is labor intensive in both nations. The ppf of labor-abundant Nation 1 is biased towards Good X, the labor-intensive product. The ppf of capital-abundant Nation 2 is biased towards Good Y, the capitalintensive product.



For the same preferences in each nation, (the indifference curves shown in Fig. 5.2 have identical shapes), the opportunity cost of Good X is higher in Nation 2 than in Nation 1. (Recall that the slope of the ppf, $\Delta Y/\Delta X$, is the opportunity cost of Good X.) Thus, Nation 1 with an abundance of labor will have a comparative advantage in the labor-intensive good. Nation 2, with an abundance of capital, will have a comparative advantage in the capital-intensive good.

Prior to trade, a labor-abundant country will have a comparative advantage in the labor-intensive product and so specialize in the labor-intensive product. The increased production of the labor-intensive produce will require more resources (capital and labor). The resources will come from the capitalintensive product, whose production will decrease as imports of the capitalintensive product increases. The capital-intensive product will release relatively more capital and relatively less labor than is demanded by the expanding production of the labor-intensive product. The consequence is an excess demand for labor and an excess supply of capital. The excess demand for labor will cause the wage rate to increase and the excess supply of capital will cause the price of capital to decrease. (It is useful to go back and review this argument until it's guite clear.) The conclusion is that in a labor-abundant country, trade will cause the price of labor to increase and the price of capital to decrease. In a capital-abundant country the reverse reallocation occurs, so trade will cause the price of capital to increase in a capital-abundant country and cause the price of labor to decrease. This change in the price of labor and the price of capital applies to both nominal and real wages.

This statement about trade and factor prices is what is known as the **Stolper-Samuelson Theorem**. Although the Stolper-Samuelson Theorem was originally applied to changes in tariffs, the Theorem also applies to changes in resource use to due to trade. The Stolper-Samuelson Theorem in the context of tariffs is developed in Chapter 8 of *International Economics*.

This conclusion suggests that a labor-abundant nation that has a low relative wage will find that trade increases its relative wage, approaching the falling relative wage of the capital-abundant nation. In fact, a second principal conclusion of the H-O model is that trade equalizes relative factor prices. If the source of different product prices is different factor prices, then when trade equalizes relative product prices, it also equalizes relative factor prices. This is demonstrated in Fig.5.3.



Nation 1 has a low relative wage because it is labor abundant. Because Nation 1 has a low relative wage, it can produce Good X at a relatively cheaper price than can Nation 2. Note a positive relationship between the relative wage and the price of Good X: as the relative wage increases the relative price of the labor-intensive good increases. The upward-sloping line in Fig. 5.3 shows this positive relationship between w/r and P_X/P_Y . Because trade equalizes prices, shown at $(P_X/P_Y)^*$ in Fig. 5.3, trade must also equalize the factor-price ratio, shown as $(w/r)^*$ in Fig. 5.3. (Note that $(P_X/P_Y)^*$ in Fig. 5.3 is the equilibrium terms of trade, the determination of which was described in Chapter 4.)

Not only are relative factor prices equalized as a result of trade, but *absolute* factor prices are also equalized, given the assumptions of the H-O model. This conclusion flows from the basic assumptions of **perfectly competitive markets** and similar technologies. In perfectly competitive markets, factors are paid the value of their marginal product. The value of marginal product is the dollar value of the additional units of a product produced by an additional worker. If an additional worker adds 10 units of production that sell for \$40 each, then the value of the marginal product is \$400. If a worker received a wage less than \$400, then other firms would compete away the worker at a higher wage. If the wage were more than the value of the marginal product, then the worker would not be hired, causing the wage to fall.

Now, if technologies are identical across nations, as assumed in the H-O theory, then the marginal products of labor will be identical across countries and the marginal products of capital will be identical across countries. Product prices will be equalized by the act of trade, so the value of marginal products will be identical across countries. Competition will now force all wages to equal the value of labor's marginal product. Trade will cause the wage rate in Switzerland to be the same as the wage rate in Germany for the same kind of factors of production. Similarly, trade will cause the price of capital in the United States to be the same as the price of capital in Mexico. The conclusion that trade will equalize both absolute and relative factor prices is the **factor-price equalization theorem**, or the **Heckscher-Ohlin-Samuelson (H-O-S) theorem**.

The factor-price equalization theorem also indicates the effect of trade on income distribution *within* a country. In a capital-abundant nation, the price of capital (r) increases and the price of labor (w) decreases. (The reverse happens for a labor-abundant nation.) However, because trade increases overall income, the loss of income by workers is exceeded by the gain in income by owners of capital.

Research on the empirical relevance of the Heckscher-Ohlin model begins with a famous study by Vassily Leontief. Leontief measured the labor and capital content of a representative basket of exports and import-competing goods. Leontief's result, known as the **Leontief Paradox**, was that the United States imports capital-intensive goods and exports labor-intensive goods, in direct opposition to the predictions of the H-O model.

Attempts to explain the H-O model has resulted in significant new research, the most important of which is the extension of the H-O model to include other inputs besides capital and labor, especially **human capital**, research and development, and natural resources. Based on more recent research, the H-O model appears appropriate for trade between developed and developing countries, and for manufactured goods. Remaining trade patterns are explained by new trade theories that include economies of scale and imperfect competition, which are addressed in the next chapter.

III. Questions

1. The capital and labor requirements for the production of **one unit** of Textiles and **one unit** of Computers is provided in Table 1.

	Textiles	Computers
Capital Requirements	10	8
Labor Requirements	10	2

a) Which good, textiles or computers, uses more units of capital in producing one unit?

b) Calculate the capital-labor ratios in the production of textiles and computers. Which good's production is capital intensive?

c) Which good uses more units of labor per unit of production?

d) Calculate the **labor-capital ratios** in the production of textiles and computers. Which good's production is labor intensive?

2. a) Assume the same input requirements in production from question 1. Based on the ppfs in Fig. 5.4, which country is relatively capital abundant?



b) Does this country necessarily have a greater stock of capital?

3. a) Use the ppf for Nation 2 in Fig 5.4 and likely terms of trade to show the effect of trade on Nation 2. Indicate the levels of production, consumption, exports, imports, and the change in welfare.

b) What have you assumed about employment before and after trade in your answer to part a? Is this likely?

4. Continue the example from Questions 1-3.

a) If demand is the same for products in both countries, which country, Nation 1 or 2, will exhibit a higher relative wage (w/r) before trade?

b) Explain what will cause wages to change in Nation 1 as a result of trade.

c) If demand is the same for products in both countries, which country, Nation 1 or 2, will exhibit a higher relative wage after trade?

d) If factor-price equalization does occur, will Nations 1 and 2 end up with the same per capita income?

5. a) Suppose Nation 1 in the above example is found to be exporting Computers. Explain why this is an example of the Leontief paradox.

b) Suggest an explanation of this finding that is consistent with the spirit of the H-O model.

c) Suggest an explanation of this finding based on demand in the two countries.

6. The ppfs of England and Ireland are shown in Fig. 5.5. The only two factors of production are labor and land, and England is land abundant.



a) Which product is land intensive?

b) If demand is identical in the two countries (same preference maps) which nation will have the comparative advantage in corn?

c) Is your answer to b consistent with the endowments model explanation of trade?

7. In the economies described in Question 6, income is earned by landlords when renting land and income is earned by labor when hiring out their labor time.

a) How will the landlords in England feel about trade with Ireland?

b) After trade, what will the rental rate of land be in England relative to the rental

rate of land in Ireland?

c) What will happen to the income of landlords, labor, and total income in England?

d) What will happen to the income of landlords, labor, and total income in Ireland?