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MARKUS HAACKER

■ Heckscher-Ohlin model

The Heckscher-Ohlin (H-O) model, which originated in Heckscher (1919) and Ohlin (1933) and was formalized and given narrower interpretation by Samuelson (1948), differs from the Ricardian theory of comparative advantage in two key respects. First, the Ricardian theory assumes only one factor of production, which robs it of any ability to address the internal income distribution effects of international trade. In contrast, the H-O theory allows for two factors of production, which opens the door to internal income distribution effects of trade. Second, whereas the Ricardian theory relies on the differences in technology across countries as the source of international trade, the H-O theory assumes the existence of the same technology everywhere and relies on the international differences in factor endowments as the basis of trade.

Because the H-O model allows economists to analyze the income distribution effects and plausibly gives a central role to intercountry differences in factor endowment rather than technology, which diffuses relatively rapidly internationally, it has come to serve as the main workhorse of trade theorists. The model leads to the conclusion that each country exports the goods that use its relatively abundant factor more intensively and such exports lead to a rise in the real and relative return to the latter. Symmetrically, the country imports products using its scarce factor more intensively, which lowers the real and relative return to the latter.

Recently, increased wage inequality in the rich countries as measured by skilled-to-unskilled wage has brought this model further to the center of the policy debate. Those favoring protection over free trade argue that just as the H-O model predicts, trade liberalization by skilled-labor-abundant rich countries has led to the rise in skilled-to-unskilled wage. Pro-free-trade economists argue, however, that the real culprit behind the phenomenon is technological advances in skilled-labor-intensive industries, which has led to a shift in demand in favor of skilled labor.

The Setting and Principal Results The following will largely focus on the strict two-factor, two-good, and two-country version of the H-O model, as formalized by Samuelson (1948). This version is narrower than originally conceived by Ohlin (1933) but is now widely used by trade economists. To formally outline the key assumptions and structure of the model, call the countries Home Country (HC) and Foreign Country (FC), products Corn (C) and Shirts (S), and factors Land (T) and Labor (L). Assume constant returns to scale in the production of each good. This means doubling the use of each factor in C doubles the output of C. The same holds true for S. Goods C and S require different technologies. Specifically, we assume that C is land intensive in the sense that at any given set of factor prices, the land-labor ratio in the production of C is higher than that in S: $T_C/L_C > T_S/L_S$. Here

T_C denotes the quantity of land employed in the production of C. A similar interpretation applies to L_C, T_S, and L_S. By implication, S is relatively labor intensive. Assuming both goods are produced in equilibrium and there is perfect competition in all markets, the H-O model leads to the following two theorems:

The Stolper-Samuelson (1941) theorem: An exogenous increase in the relative price of a good leads to an increase in the real and relative return to the factor used more intensively in that good and a decrease in the real and relative return to the other factor. For example, an increase in the price of C increases the real and relative return to land, which is used more intensively in the latter. It also leads to a decline in the real and relative return to labor, which is used more intensively in S.

The Rybczynski (1955) theorem: Holding the goods prices constant, an increase in the endowment of a factor leads to a proportionately larger increase in the output of the good using that factor more intensively and a decline in the output of the other good. For example, holding the goods prices constant, a 1 percent increase in the endowment of labor would raise the output of S, which uses labor more intensively, by more than 1 percent and lower the output of C.

Suppose we additionally assume that HC is land abundant relative to FC. Formally, using an asterisk to distinguish the variables associated with FC, $T/L > T^*/L^*$. The two countries have the same technology of production available. These two additional results follow:

The Heckscher-Ohlin theorem: The opening to trade leads each country to export the good using its abundant factor more intensively and to import the other good. For example, the land-abundant HC exports the land-intensive good C and imports the labor-intensive good S.

The Factor-Price Equalization theorem: Absent transportation costs, the opening to trade equalizes not only the goods prices but factor prices as well. That is to say, in a trading equilibrium, the HC ends up with the same real and relative wage and rental price of land as FC.

Deriving the Theorems Let us denote the wage by w and the rental price of land by r. The proportion of land to labor in C, T_C/L_C, depends on w/r. Specifically, as labor becomes more expensive relative to land, firms economize on the use of labor and employ land more liberally. In other words, as w/r rises, they raise the land-labor ratio. This relationship is shown by curve CC′ in figure 1.

We assume that C is land intensive relative to S. This means that at each wage-rental ratio, C uses more land per unit of labor than S. In terms of figure 1, the line showing the land-labor ratio in S at different wage-rental ratios, SS′, lies everywhere below CC′.

Represent the land-labor ratio of HC in figure 1 by T/L. We can then determine the range of possible wage-rental ratios in HC. At a sufficiently high relative price of C, the economy specializes completely in this product. In this case, the land-labor ratio in C coincides with the economy's land-labor endowment ratio, and the wage-rental ratio is given by $(w/r)_{min}$ in figure 1. At the other extreme, if the price of C is sufficiently low, the economy specializes completely in S, the land-labor ratio in S coincides with the economy's land-labor ratio, and the wage-rental ratio is given by $(w/r)_{max}$ in figure 1. At an intermediate price ratio, both goods are produced and the wage-rental ratio is between the two extremes.

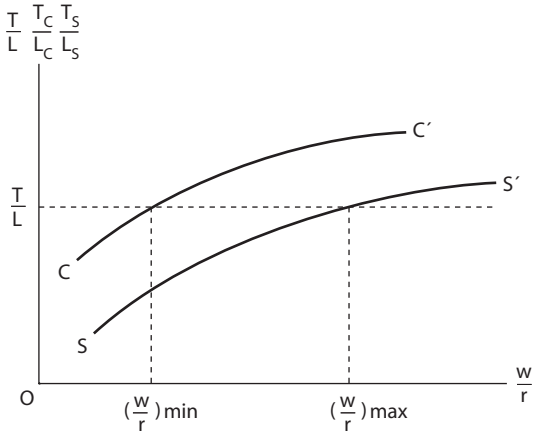

Figure 1
Factor prices and factor intensities

As we move from $(w/r)_{min}$ toward $(w/r)_{max}$, we increase the output of S and reduce that of C. With the wage-rental ratio rising during this movement, both sectors raise the land-labor ratio, and thus allow the labor-intensive sector S to expand.

Figure 2 shows the output changes just described using the construction of the production possibilities frontier (PPF). Given technology and factor endowments, MN shows the PPF of HC. The absolute value of the slope of the PPF at any point gives the opportunity cost of the product on the horizontal axis (C) in terms of the product on the vertical axis (S). The PPF is bowed out, which means that the marginal opportunity cost of each product in terms of the other rises as we expand the output of that product. For example, as we move from M toward N, the absolute value of the slope rises, meaning that the opportunity cost of C in terms of S rises with the rising output of C. This rising cost is the result of the imperfect substitutability between land and labor. To expand the production of C, which is land intensive, we must lower the land-labor ratio in each product. The more we substitute labor for land, the lower the marginal return to such substitution and the higher the marginal cost of further expansion.

Under perfect competition, production takes place at a point where the marginal cost equals the price. Therefore, letting $(P_C/P_S)^0$ represent the relative price, the economy would produce at a point such as Q^0 in figure 2 where the price line is tangent to the PPF. The tangency ensures that the relative price equals the marginal opportunity cost of production.

Starting at Q^0, suppose we consider a small increase in the relative price of C. This would lead to an increase in the output of C and decrease in the output of S. At the original factor prices, the expansion of C would require more land per worker than S releases. This creates an excess demand for land and excess supply of labor. The return to land rises and that to labor falls. That is to say, a rising price of C, which is land intensive, is associated with a declining w/r ratio.

Let us plot these relationships in figure 3. In the right-hand panel, curve RS shows increasing supply of C relative to S as a function of the relative price of C, P_C/P_S. In the left-hand panel, curve RR′ shows an inverse relationship between wage-rental ratio and the relative price of C. This latter relationship partially represents the Stolper-Samuelson theorem: it connects the goods prices to the relative factor prices. The representation is only partial since the Stolper-Samuelson theorem also relates the price change to the real factor returns.

To elaborate on how the Stolper-Samuelson theorem works, consider a move from autarky to free trade by HC. Suppose that the world relative price of C exceeds its autarky price. This means HC would export C and import S under free trade. As already

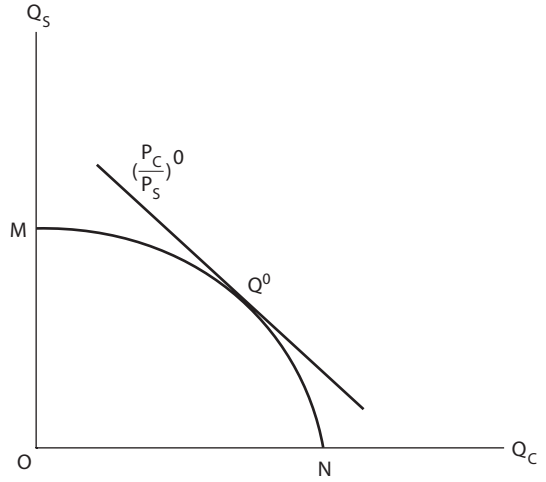

Figure 2
The production equilibrium

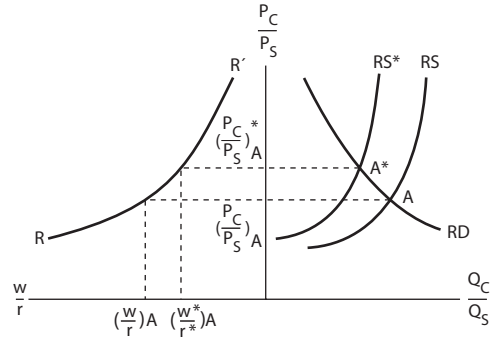

Figure 3
The Heckscher-Ohlin factor price equalization theorems

explained, the higher price of C brought about by trade would increase the output of C and lower the wage-rental ratio (see left-hand panel in figure 3). The income distribution within HC would move against workers and in favor of landowners. The critical question is whether the workers could still be better off in real terms due to the decline in the relative price of good S brought about by trade. The Stolper-Samuelson theorem answers this question in the negative: the wage declines not just in terms of good C whose price rises but also in terms of S whose price falls.

To see how this works, note that the firms employ workers up to the point where the wage equals the value of marginal product of labor. Denoting the marginal product of labor in C and S by MPL_C and MPL_S, respectively, we have

$$w = P_C.MPL_C = P_S.MPL_S \quad (1)$$

Rearranging, this equation implies

$$w/P_C = MPL_C \text{ and } w/P_S = MPL_S \quad (2)$$

That is to say, the purchasing power of the wage in terms of a commodity equals the marginal product of labor in that commodity. This purchasing power rises or falls as the marginal product of labor in the product rises or falls. A similar relationship applies to land: the purchasing power of rental income in terms of a good rises or falls as the marginal product of land in the production of that good rises or falls.

To determine what happens to the marginal product, recall that as C expands, the wage-rental rate falls, which leads to a decline in the land-labor ratio in each product. The decline in the land-labor ratio implies a decline in the marginal product of labor and a rise in the marginal product of land in terms of each product. It follows that the real return to labor falls and that to land rises in terms of each good. In effect, the decline in the wage is sharper than the decline in the price of good S, leaving the workers worse off even if they spend their entire wage income on that good.

Next, let us consider the effects of a change in the factor endowments at a given goods price ratio. To take a concrete example, let us increase the endowment of labor by 5 units. From curve RR′ in figure 3, we know that as long as we hold the goods price constant, the relative factor prices remain constant as well. Figure 1 then tells us that the land-labor ratios in the two goods must also remain unchanged. The economy must absorb the additional labor supply without altering the land-labor ratios. This constraint immediately rules out a simple-minded division of the additional units of labor between the two sectors without reallocation of land since such allocation would necessarily change the land-labor ratio in each product.

To see what kind of reallocations would be compatible with full employment at unchanging land-labor ratios, begin by placing the entire additional labor supply in the labor-intensive good S. To maintain the original land-labor ratio, this requires drawing land from C to work with the additional five units of labor in S. But since C must also maintain its original land-labor ratio, it would not release land without releasing labor. This means that S must absorb not just the 5 new units of labor but also those released by C as it releases land.

For concreteness, suppose the land-labor ratio is 3 in C and 2 in S. Then each time C releases 3 units of land, it releases 1 unit of labor. But since the land-labor ratio in S is 2, it employs 1.5 units of labor for each 3 units of land. In other words, moving 3 units of land out of C allows S to absorb 1 unit of labor released by C plus a half unit out of the new 5 units. Therefore, if we move 30 units of land from C to S, the latter would absorb 15 units of labor that are exactly equal to the sum of the 10 units released by C and 5 new units. Full employment is achieved at unchanging land-labor ratios.

This example illustrates that a given expansion of the endowment of a factor leads to a proportionately larger expansion of the sector using that factor more intensively and a contraction of the other sector. We thus have the Rybczynski theorem, named after T. M. Rybczynski (1955), who first noted the result. The result is generalized in the sense that if both factors expand but the land-labor ratio declines, the output of the land-intensive good relative to the labor-intensive good falls as well.

The Rybczynski theorem is a key building block of the Heckscher-Ohlin theorem. Recall that we

have assumed FC to be relatively labor abundant: $L^*/T^* > L/T$. An immediate implication of the Rybczynski theorem is that at any given price ratio, FC produces less C relative to S than HC. Therefore, denoting by Q_i the quantity of output of good i ($i = C, S$), we have $Q_C^*/Q_S^* < Q_C/Q_S$ at each price ratio. This is shown by the relative supply curve RS* in figure 3.

Assuming the relative demand depends only on the relative price and the consumers in HC and FC are identical, we can represent the demand in the two countries by a common demand curve RD in figure 3. The autarky equilibriums in HC and FC are then given by A and A*. It is straightforward that under autarky the land-intensive good C is cheaper in the land-abundant country HC and the labor-intensive good S is cheaper in the labor-abundant country FC. Therefore, when the two countries open to trade, each country would export the good that uses its abundant factor more intensively, just as the Heckscher-Ohlin theorem predicts (see above).

Finally, observe that, as the left-hand panel of figure 3 shows, under autarky the wage-rental rate is higher in the labor-scarce HC than in the labor-abundant FC. The opening to trade leads to a rise in the relative price of C in HC. This leads to a fall in the wage-rental rate there. The opposite happens in FC: the relative price of C declines there, which leads to a rise in the wage-rental rate. Therefore, the factor prices converge between the two countries. Assuming no transport costs, trade would equalize the goods prices. But as goods prices equalize, the wage-rental rate would equalize as well.

Given the same wage-rental rates in the two countries at the free-trade equilibrium, figure 1 tells us that the land-labor ratios across countries would also equalize for each product. This would then lead to the equalization of the marginal products and hence real factor prices of each product. Free trade would lead to the equalization of the relative and real factor returns internationally, as predicted by the factor price equalization theorem (see above).

Trade and Wages In the contemporary policy literature, the Stolper-Samuelson and factor price equalization theorems have played a crucial role. Between the late 1970s and early 1990s, the real and relative wages of unskilled workers in relation to skilled workers in the rich countries declined. The ratio of skilled-to-unskilled wages, a measure of wage inequality, rose almost 30 percent in the United States. This period also coincided with a rapid expansion of trade between developed and developing countries. This led many to link the changes in the wages to the opening to trade via the Stolper-Samuelson theorem. If we think of the two factors in the H-O model as skilled and unskilled workers, the developed countries are importers of unskilled-labor-intensive goods. The H-O theory then predicts that opening to trade with the developing countries would push down the real and relative wages of the unskilled. In the spirit of the factor price equalization theorem, some observers have gone so far as to suggest that the wages of the unskilled in the developed countries may be pushed down to the levels prevailing in the developing countries.

Trade economists disagree with this diagnosis and argue that trade with the poor countries cannot explain the bulk of the increase in the wage inequality. They cite four reasons in support of their position.

- Trade works to lower the unskilled wage by lowering the relative price of unskilled-labor-intensive goods. But a study by Lawrence and Slaughter (1993) pointed out that the relative price of unskilled-labor-intensive goods had actually risen since the late 1970s. By itself this point is not decisive, however. In principle, trade may have lowered the relative price of unskilled-labor-intensive products but other factors such as sharply declining costs of skilled-labor-intensive products may have reversed this decline. Lawrence and Slaughter only looked at the ex post change in the prices but did not decompose them according to the sources of the change. Therefore, their analysis remains incomplete.
- Extra imports from the developing countries during the relevant period account for less than 2 percent of the total expenditure

in the United States. This is the point made by Krugman (1995). He argues that such a small proportionate expansion of trade can simply not explain the large increase in wage inequality. This is a valid and important point.

- During this period, wage inequality rose in many developing countries as well. If the simple-minded Stolper-Samuelson theorem was driving the outcome, developing countries should have experienced a decrease in wage inequality. Given that they export unskilled-labor-intensive goods, the Stolper-Samuelson theorem should have driven their real and relative unskilled wages up. This did not happen.
- Technical change that shifted labor demand in favor of skilled labor and away from unskilled labor provides a far more compelling explanation for increased wage inequality in both rich and poor countries. Technological change has been concentrated in skilled-labor-intensive goods, and it has also moved progressively toward greater use of skilled labor. This change has shifted the demand in favor of skilled labor in both rich and poor countries and led to increased wage inequality in both regions.

The Heckscher-Ohlin model is the principal workhorse of trade economists. It shows that countries export goods that use their abundant factors more intensively and import goods that use their scarce factors more intensively. Given that imports bring goods that use the scarce factors more intensively, they lower the demand for and hence the returns to such factors locally. This conclusion has led to widespread claims that the imports of unskilled-labor-intensive goods from the poor countries have lowered real and relative wages of unskilled workers in the rich countries. Most trade economists disagree with this conclusion, arguing that a shift in technology in favor of skilled labor and away from unskilled labor is the true cause of the decline in the fortunes of unskilled workers.

See also comparative advantage; factor endowments and foreign direct investment; Ricardian model; specific-factors model; trade and wages

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ARVIND PANAGARIYA

■ hedge funds

Hedge funds are broadly defined as private investment pools that are not available to the general public. They are more lightly regulated and have wider investment flexibility than public investment companies such as mutual funds, which pool money from many investors and invest in stocks, bonds, and other securities. Hedge funds can buy and sell securities in many financial markets, representing long and short positions, respectively. In addition, they can use leverage and derivatives, which are financial instruments whose value derives from some underlying asset or price.

The first hedge fund was started in 1949 by Alfred Winslow Jones, a financial journalist, who believed that this new investment style could deliver good returns with more stability than investments in stock mutual funds. The hedge fund industry has grown from 600 funds in 1990 to more than 8,500 in 2005. During the same period, total assets in hedge funds have grown from $40 billion to more than $1 trillion. This growth has been driven by the stable investment performance of the industry, especially when compared to the swings of the stock market. Because they pursue very active investment strategies, hedge funds are even more important than their asset size would suggest. As a result, hedge funds have become major players in international capital markets.

Types of Hedge Funds The hedge fund industry is much more heterogeneous than the mutual fund industry because of the greater latitude in investment style. Funds are typically classified into the following categories:

Global macro funds, which take positions in global markets (stocks, fixed-income investments, currencies, commodities);

Long/short equity funds, which buy and sell stocks;

Equity market neutral funds, where the long positions are exactly offset by short positions so as to create a zero, or neutral exposure to the stock market;

Arbitrage funds, which take long and short positions in securities such as fixed-income and convertible bonds;

Event-driven funds (merger arbitrage and distressed debt), which take positions driven by corporate events such as mergers, takeovers, reorganizations, and bankruptcies.

Long/short equity funds represent the largest sector of the industry, with approximately one-third of the funds.

Investment Strategy Consider a typical hedge fund, which has both long and short positions in stocks. Say the initial capital is $100. This represents the equity, or net asset value. The fund buys $100 worth of stocks and sells $50 worth of other stocks. Short-selling is achieved by borrowing a stock and selling it in the hope that its price will fall later, at which time the stock can be bought back and transferred to the lender. In such case, the borrower keeps the difference between the (higher) earlier sales price for the stock and the (lower) later purchase price. In the event that the stock price goes up, however, the borrower loses the difference between the (lower) earlier sales price and the (higher) later purchase price.

This type of investment strategy (short-selling) has two advantages relative to mutual funds, which typically are allowed to have long positions only. First, it allows the hedge fund manager the flexibility to buy assets that are viewed as undervalued, for example, and sell assets that are overvalued. In contrast , the manager of a long-only fund cannot implement a view that an overvalued asset is going to fall in price, because the manager cannot short the asset.

Second, it has less exposure to the direction of the stock market (called *directional exposure*) than a long-only position. Indeed, to "hedge" a bet can be defined