

Appendix to Chapter 4 • The Heckscher-Ohlin Model with Variable Coefficients

In the main body of this chapter we examined a two-factor model with *fixed coefficients*. That is, the ratio of land to labor used in the production of each good was assumed to be wholly determined by technology. This is a useful simplification, but in the real world the possibility of substitution between factors is important. For example, firms in a country with cheap labor may choose to use less capital-intensive and more labor-intensive techniques of production than they would in a country with expensive labor. We want to be sure the basic insights of our chapter are not lost when we allow for such substitution. This appendix briefly shows how a two-factor model of an economy works when coefficients are variable.

CHOICE OF TECHNIQUE

The key new element we need to introduce is that firms have a choice about the land- or labor-intensity of production of each good. They can choose to use less land per unit of output if they are willing to use more labor. Figure 4A-1 illustrates this trade-off for cloth. Curve *I*, which shows different bundles of labor and land that can produce 1 unit of cloth, is referred to as the *unit isoquant* for cloth.

Firms will choose the ratio of land to labor that minimizes the cost of producing cloth. The details of this choice are discussed in microeconomics texts. The basic result is not surprising:

FIGURE 4A-1
The unit isoquant for cloth.
The more labor that is used in producing a unit of cloth, the less land is needed.

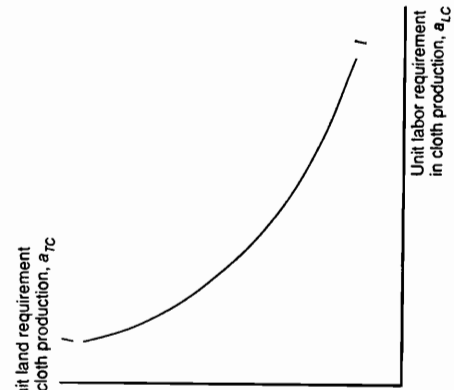
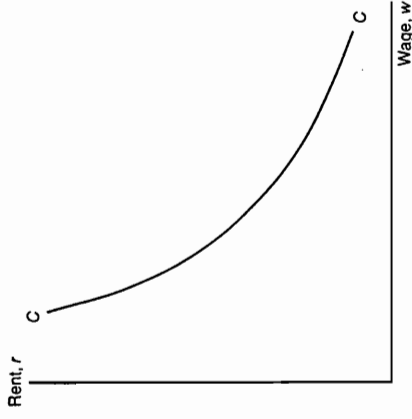


FIGURE 4A-2

Factor prices such that price equals cost. The curve *CC* shows all combinations of *w* and *r* such that the cost of producing a unit of cloth equals its price. The higher *w* is, the lower *r* must be to leave the production cost the same.



the cost-minimizing land-labor ratio a_{rC}/a_{wC} is inversely related to the ratio of the price of land to that of labor, r/w .

GOODS PRICES AND FACTOR PRICES

The price of each good must equal its cost of production. For any given price of a good, this requirement defines a set of possible factor prices. For example, given the price of cloth, the higher the wage rate *w* the lower must be the rental rate *r* (Figure 4A-2). The economy's factor prices must be such that the cost of production equals the price in both cloth and food (Figure 4A-3). Curve *CC* represents all combinations of *w* and *r* for which price equals cost in cloth,

FIGURE 4A-3

Determination of *w* and *r*.
In equilibrium, the cost of producing a unit of cloth must equal its price, and so must the cost of producing a unit of food. Thus *w* and *r* are determined by the intersection of *CC* and *FF*.

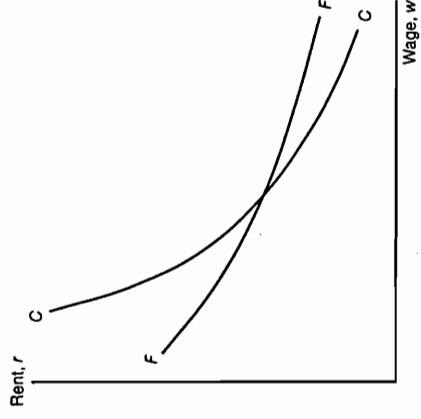
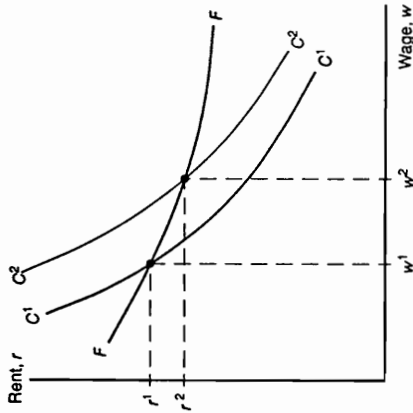


FIGURE 4A-4

A rise in the price of cloth. An increase in the price of cloth shifts CC out from C^1C^1 to C^2C^2 . This raises the wage rate from w^1 to w^2 , while lowering the rental rate from r^1 to r^2 .



while FF represents all combinations for which price and cost are equal in food. Since cloth is more labor-intensive and less land-intensive than food, the wage rate has relatively more effect on the cost of cloth production, and the rental on land less effect. As a result, to offset the effect of higher w on cloth production cost, r must fall more than is true for food; thus CC is steeper than FF .

If the price of cloth rises, the cloth industry is able to pay a higher wage, a higher rent on land, or both: CC shifts out from C^1C^1 to C^2C^2 (Figure 4A-4). This raises the wage rate from w^1 to w^2 , while lowering r from r^1 to r^2 . The rise in w must be more than proportional to the increase in P_C . Thus in the variable-coefficients model, as in the fixed-coefficients model, changes in relative prices have strong effects on the distribution of income.

ALLOCATION OF RESOURCES

To determine how the economy allocates resources between cloth and food production, given goods prices, we follow three steps: (1) Use goods prices to determine factor prices. (2) Use factor prices to determine the land-labor ratio in each sector. (3) Use the assumption that land and labor are both fully employed to determine resource allocation.

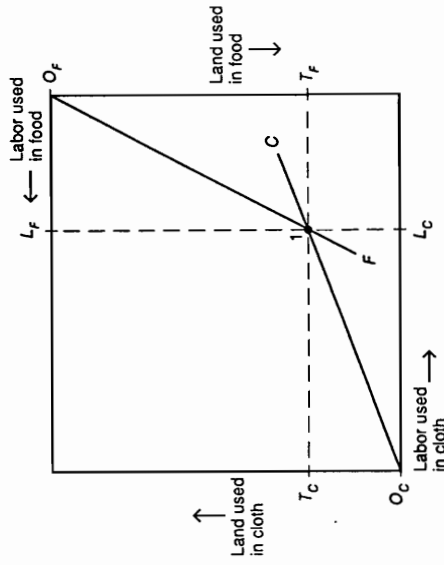
Figure 4A-5 shows how step 3 works. The economy's resources are represented by the sides of a box. The width of the box represents the economy's supply of labor, while its height represents the supply of land. We measure resources used to produce cloth from the lower left corner of the box (O_C) and resources used to produce food from the upper right corner (O_F). The ratio of land to labor in cloth production is shown by the slope of the line $O_C C$, while the land-labor ratio in food is the slope of $O_F F$.

The allocation of land and labor that allows both to be fully employed is at point 1, where $O_C C$ and $O_F F$ cross. The economy allocates $O_C L_C$ units of labor and $O_C T_C$ units of land to cloth production, $O_F L_F$ labor and $O_F T_F$ land to food production.

Now we ask what happens if the economy's supply of land increases (Figure 4A-6). The box expands, so that after the land supply increase the resources used in food are measured from O_F^1 instead of O_F . The key point is to look at resources used in cloth production. As the equilibrium allocation shifts from point 1 to point 2, both land and labor used in cloth production fall, from $O_C T_C$ to $O_C T_C^1$ and from $O_C L_C$ to $O_C L_C^1$, respectively. As a result, cloth production

FIGURE 4A-5

Allocation of resources in the variable-coefficients case. Inputs to cloth production are measured from the lower left corner of the box, inputs to food production from the upper right corner. Given the land-labor ratios in the two industries, point 1 is the only allocation that fully employs both resources.



declines. Correspondingly, land and labor employed to produce food, and thus food production, must rise.

The result that an increase in land supply actually leads to a fall in the production of the labor-intensive good confirms our result from the fixed-coefficients model: increases in factor supplies have strongly biased effects on production.

Finally, it is clear from Figure 4A-6 that if we were to keep increasing the economy's land supply, still holding goods prices fixed, eventually no resources at all would be used to produce cloth: the economy would specialize in food production. The general point is that a trading economy whose land-labor ratio is either very high or very low will specialize in producing only one good.

FIGURE 4A-6

An increase in the supply of land. An increase in the supply of land expands the box and shifts the allocation of resources from point 1 to point 2. Production of food rises, but production of cloth actually falls.

