

The Specific-Factors Model: HO Model in the Short Run

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In this chapter we relax one of the assumptions of the HO model. The assumption of perfectly mobility of factors is intended to capture the state of the economy in the long run. For example, a worker in advertising cannot seamlessly shift into computer programming. It would require the worker to acquire programming skills in order to do so, which will require some time. Similarly, capital used to produce typewriters is very different from that used to make today's computers. It would require the depreciation of capital in the typewriter producing sector and accumulation of capital in the computer producing sector. Therefore, in the short run, there is imperfect mobility of factors. In other words, factors are sector-specific.

So, instead of the HO model's assumption of perfectly mobile factors, we are going to assume that factors are sector specific. Thus, the HO model studied in the previous chapter is a long-run analysis, and this *specific-factors* model is a short-run analysis. Will the results of the original HO model, the FPE theorem, the Stolper-Samuleson theorem and the Rybczynski theorem still hold? Let us see.

Consider a world with two countries (home - H , foreign - F), which can produce two goods (good X and good Y) using two factors of production, labor and capital. Though labor is perfectly mobile and homogeneous, capital is specific to the industry. For now, for simplicity, we drop the country superscripts. The productions functions of the two goods are assumed to be CRS and are given by:

$$X = F_x(R_x, L_x) \quad ,$$

$$Y = F_y(S_y, L_y) \quad .$$

R_x and S_y denote the types of capital that are specific to sectors X and Y , respectively. Resource constraints require that

$$R_x = \bar{R} \quad ,$$

$$S_y = \bar{S} \quad ,$$

$$L_x + L_y = \bar{L} \quad ,$$

where \bar{R} and \bar{S} are the endowments of the two types of capital, respectively, and \bar{L} is the endowment of labor. The return to labor (wage), denoted by w , is the same for the two

sectors, but due to sector-specific capital stocks the returns to R and S may be different, and are therefore denoted by r and s .

Note that because R and S are fixed, labor will face diminishing returns, i.e. diminishing marginal product, as we add more and more units of labor to the fixed stocks of capital in the two sectors. However, any increase in the stocks of R or S will shift the marginal product curve up in that sector, implying that the same units of labor will have a higher marginal product - increase in labor productivity due to increase in capital stock. This is similar to the positive relationship between K/L ratio and marginal product we saw in the more general model in the last chapter. Just like labor, capital is also subject to diminishing returns in both sectors, i.e. increasing the stock of capital keeping units of labor the same reduces the marginal product of capital. We stick to the assumption of perfectly competitive factor markets, so that

$$VMP_{LX} = MP_{LX}p_x = VMP_{LY} = MP_{LY}p_y = w \quad ,$$

$$VMP_{KX} = MP_{KX}p_x = r \quad ,$$

$$VMP_{KY} = MP_{KY}p_y = s \quad .$$

Another way to state these results is that the real return to a factor ($w/p_x, w/p_y, r/p_x, s/p_y$) equals its marginal product. The marginal product is just the function of the K/L ratio. Therefore, if the K/L ratio increases in a sector, it raises the marginal product of labor, and hence real wage, in that sector and reduces the marginal product of capital, and hence real rental rate, in that sector.

We analyze the equilibrium in figure 1. In equilibrium, due to free mobility of labor, both sectors will have the same wage rate, i.e. equal value of marginal product. Origin for sector X is O_x and origin for sector Y is O_y . Employment in sector X is measured from left to right, whereas that for sector Y is measured from right to left.

For a given p_x and fixed capital stock in sector X , as more labor is employed in the sector the marginal product of labor declines, which in turn implies that the value of marginal product also declines. This explains the downward sloping VMP_{LX} curve (and also the downward sloping VMP_{LY} , for given p_y and fixed S in sector Y). The VMP_L curves

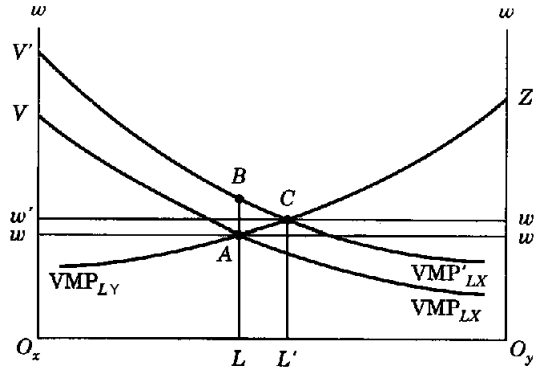


Figure 1: Autarky and Trade Equilibrium

capture the inverse relationship between wage and quantity of labor demanded, and hence also represent the demand curves for labor in the two sectors. Equilibrium is established where the wage rate, or the value of marginal product, is equalized across the sectors. For the case of autarky, this happens at point A . As a result, O_xL is the employment in sector X and O_yL is the employment in sector Y . The total nominal labor income paid in sector X is the area wO_xLA and that paid in sector Y is the area wO_yLA . The remaining area under the VMP_L curve is income of the specific capital in each sector. Thus, in autarky, R earns the area VwA and S earns the area ZwA .

Let us now analyze the effect of trade on this economy. Suppose, the closed economy is small and upon opening up to trade, it faces a higher price of good X abroad. Assume that the price of good Y is the same as in the world. Therefore, the small economy will export good X and the price will rise to the world level. So what is the effect of the rise in the price of good X ? A higher p_x will shift VMP_{LX} to VMP'_{LX} . If the labor allocations remained unchanged the economy would move to point B . However, at B , the wage in sector X is higher than that in sector Y . This will induce labor to move from Y to X (capital cannot move because it is fixed). This will lower the K/L ratio in sector X , which will reduce the marginal product of labor in X . As a result, the economy will move down along the VMP'_{LX} curve, and equilibrium will be established at point C where the wage is equal across the two sectors. At C , as compared to A , labor allocation to sector X is higher.

1 Goods Prices and Factor Prices

What is the effect of this change in relative commodity prices on factor prices? The return to factor R , the specific factor in sector X is higher. This is because the lower K/L ratio, resulting from movement of labor from Y to X and a fixed stock of R , implies a higher marginal product of capital in sector X . This implies that r rises more than p_x . Since, p_y is unchanged it implies that the return to factor R in units of good Y (r/p_y) is also higher. The return to factor S , the specific factor in sector Y , is smaller. The higher K/L ratio, due to the exodus of labor from Y , will result in a lower marginal product of capital in sector Y . Therefore, the real return to S (s/p_y) is lower in sector Y . And, since p_x is higher (and p_y is unchanged) the real return in terms of price of good X is also lower. How about return to labor? Clearly, as compared to point A at point C , the nominal wage is higher. Since the price of good Y is unchanged, labor is better off in terms of units of good Y it can buy with the same nominal wage. This is also clear from the fact that in sector Y , due to the rise in K/L ratio, the marginal product of labor is higher, implying that the real wage, w/p_y , is higher. However, in sector X , due the lower K/L ratio, the marginal product of labor is lower, implying that the real wage, w/p_x , is lower. Thus the real wage rises in the shrinking sector (sector Y) and falls in the expanding sector (sector X). So, the net effect on real wage is ambiguous.

To summarize, an increase in the relative price of a good results in an increase in the real return to the specific factor used in that sector, a decrease in the real return to the other specific factor and has an ambiguous effect on the mobile factor.

Compare this result with the Stolper-Samuelson theorem. Stolper-Samuelson theorem states that an increase in the relative price of a labor-intensive good leads to an increase in the real wage in both sectors and a decrease in the real return to capital. This is driven by the assumption of free mobility of both labor and capital. Rise in price of labor-intensive good draws resources from sector Y . Because of higher capital-intensity in sector Y , input bundles are released with higher K/L ratio than that needed to produce good X (since X is labor-intensive). As a result, both goods are produced with higher K/L ratio, which results in higher real return to labor and lower real return to capital. The free mobility of factors

and the difference in factor-intensity is crucial to obtain this result. Since the real wage declines in sector X , the specific factor receives a higher proportion of the increase in price of X . The opposite holds true for the other specific factor as the output of Y declines in the short run. So, what we have is

$$\% \Delta s < \% \Delta p_y < \% \Delta w < \% \Delta p_x < \% \Delta r \quad .$$

This is a modification of the rankings observed in case of the Stolper-Samuelson theorem, and out here the rankings depend on factor specificity. Also, the unequal effects of trade on different factors stands in contrast with the equal benefits shared by all workers in case of the Ricardian model. This model helps us understand why factors employed in some sectors may favor trade liberalization policies while factors in some other sectors may oppose them.

In the specific-factors model, we do not even talk about factor-intensity. Since the two kinds of capital stocks are different, one cannot compare K/L ratios across the two sectors. The important ingredient is the identity of mobile and fixed factors.

2 Do Factor Price Equalization Theorem and Rybczynski Thoerem hold?

2.1 Factor Price Equalization

Factor price equalization posits that as long as the production functions are CRS and identical across countries, preferences are identical and there is incomplete specialization commodity price equalization will result in factor price equalization. Mathematically, this means that factor prices are a function of commodity prices. In order to determine factor prices uniquely as function of commodity prices, one would need as many commodity prices (or commodities) as factor prices (or factors). In the specific factors model this condition is violated as there are three factors and two goods. Therefore, FPE does not hold in the specific-factors model.

Intuitively, let us consider two countries H and F and suppose H exports X and F exports Y . This will cause the real return to R to rise and that to S to fall in H . The opposite will be true in country F . In country H , labor will earn higher real wage with respect to good Y and lower real wage with respect to good X . The reverse will happen in country F .

Therefore, in the specific factors model the equalization of commodity prices by international trade does not equalize factor prices.

2.1.1 Effect of Endowment Changes on Factor Prices

Recall, in the FPE theorem, endowment changes do not lead to changes in real return to factors as long as the economy remains incompletely specialized. This is because the factor prices are a one-to-one function of commodity prices in that model. That is not the case in the specific-factor model.

To illustrate this, let us start with the trade equilibrium, at point C , in figure 2. Again, we assume that our economy is a small open economy, i.e. it takes the prices of commodities as given from the world market. Therefore, prices of the goods do not change in response to changes in the domestic economy. Consider an increase in the endowment of specific factor S . This will increase the marginal product of labor in sector Y , thereby shifting VMP_{LY} to VMP'_{LY} . This raises the wage in sector Y , which leads to shifting of labor force from sector X to sector Y until the wage is equal across the two sectors. As a result the new equilibrium is established at point T . The output of Y increases and that of X declines.

What is the effect on factor incomes? Since commodity prices are fixed, real wage is higher in both sectors. This is also clear from the fact that K/L ratio is higher in both sectors (X loses labor to Y), implying that marginal product of labor is higher. The higher K/L ratio also implies that the marginal product of capital is lower in both sector, which implies that the fixed factors are worse off in real terms. A similar picture emerges in the case where the endowment of the other specific factor, R , increases.

What happens when the endowment of the mobile factor, labor increases. This is represented by the shift of the origin for good Y from O_y to O_y^* . As a result, VMP_{LY} shift

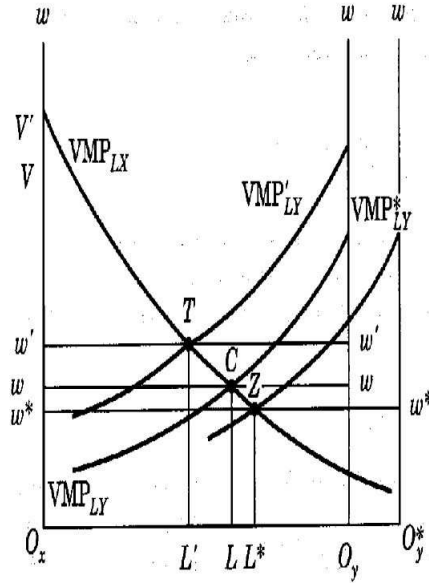


Figure 2: Effect of Change in Endowment

down to VMP_{LY}^* . New equilibrium is established at point Z , where the nominal wage rate is lower. With fixed commodity prices, this implies lower real wage. Due to the larger labor force, share of each sector in labor force is higher, resulting in lower K/L ratios. This implies that the real return to both specific factors is higher.

Thus, an increase in the endowment of a specific factor, at constant commodity prices, will lower the real return to the specific factors and increase the real return to the mobile factor. On the other hand, an increase in the endowment of the mobile factor reduces the real return to the mobile factor and increases the real return to the fixed factor.

The absence of factor-price equalization is not driven by the assumption of a small open economy. Consider the case of two large economies engaging in trade, and think of point C as the equilibrium for economy H . Suppose H is exporting Y . Then an expansion in output of due to an increase in the endowment of factor S will cause greater exports of Y and hence lower relative price of good Y . In country F this would result in an increase in the output of good X and a reduction in output of Y , causing the relative return to factor R to rise and the relative return factor S to decline. The effect on wage remains ambiguous. Similar effects take place in country H , but they do no offset the initial impact of endowment change.

Once again, we see that equalization of commodity prices, due to trade, does not result in factor price equalization.

2.2 Rybczynski Theorem

The Rybczynski theorem postulated that under constant commodity prices, an increase in the endowment of a particular factor raises the output of the commodity that uses that factor intensively and lowers the output of the other good. *In the specific factors model, we have seen that at constant commodity prices, an increase the endowment of a specific factor increases the output of the good that uses that factor and lowers the output of the other good by attracting labor from it.* This is similar to the Rybczynski result, but it driven by specificity of the factor and not factor intensity. *Furthermore, in the specific factors model a rise in the endowment of labor results in an increase in output of both goods.*

These results, violation of FPE and modification of Rybczynski theorem, give us insights into response of different factor owners toward immigration policies. Clearly, due the presence of sector-specific factors not all gains from trade are exhausted - factor prices are not equalized across countries. Thus, the factors that are not mobile domestically, would prefer to migrate to countries where there they can get a higher real return. On the other hand, factors that are mobile, would oppose freer immigration of competing mobile factors while the immobile factors would favor them.

3 Pattern of Trade

Having understood the dynamics of the specific factors model, we would like to know if the trade pattern observed in this environment is the same as that observed in the HO model. We will drop the assumption of a small open economy, and go back the two country world. Country H and F are assumed to have identical labor endowments and total capital in the *long run*. With identical preferences, then in the long run there will be no trade as the two countries will be identical in every respect.

However, in the short run, we assume that capital is not perfectly mobile. Specifically, assume that in country H there is more capital in sector Y and in country F there is more capital in sector X . In terms of the framework of sector-specific factors, it would mean that country H has a greater stock of factor S and lower stock of factor R than country F . As discussed earlier, this would result in higher output of Y and lower output of X in H than in F for any common commodity price ratio. As a result, country H will export Y and country F will export X . This means that in the short run each country will export the good that is produced with the relatively abundant specific factor. Now, instead of having identical labor endowments, consider a situation wherein country F has a larger labor force than country H . In the HO model, this would certainly mean that country F exports X (the labor-intensive commodity in the long run). However, in the specific factors model, an increase in the size of the labor force in F would mean that the output of both X and Y would increase. Which good's output will increase more is dependent on the slopes of the VMP_{LX} and VMP_{LY} curves, which in turn depend on the production functions of the two goods and the allocation of capital. If VMP_{LX} is flatter than VMP_{LY} then this would result in a greater increase in the output of X , which would in turn make it the export good of country F .

Therefore, in the specific factors model, each country exports the good with absolutely abundant stock of physical capital, assuming identical endowment of the mobile factor, labor. With differences in labor endowments, trade patterns will depend on the nature of production functions and on the allocation of capital (stocks of specific factors).