Lecture 3: Specific Factors Model of Trade

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1 Introduction

- Trade has substantial effects on the income distribution within each trading nation.

- There are two main reasons why international trade has strong effects on the distribution of income: 1) Resources cannot move immediately or costlessly from one industry to another. 2) Industries differ in the factors of production they demand.

- The specific factors model allows trade to affect income distribution.

- Some economists think this model as a model in the short run.

2 The economy under autarky

2.1 Assumption of the Model

- Assume that we are dealing with one economy that can produce two goods, manufactures and food. There are three factors of production; labor (L), capital (K) and land (T for terrain).

- Manufactures are produced using capital and labor (but not land), that is

\[ Q_M = F_M(K, L_M) \]

- Food is produced using land and labor (but not capital), that is

\[ Q_F = F_F(T, L_F) \]

- Labor is therefore a mobile factor that can be used in either sector. Land and capital are both specific factors that can be used only in the production of one good.
The full employment of labor condition requires that the economy-wide supply of labor must equal the labor employed in food plus the labor employed in manufactures

\[ L_M + L_F = L \]

Perfect Competition prevails in all markets.

### 2.2 PPF

To analyze the economy’s production possibilities, we need only to ask how the economy’s mix of output changes as labor is shifted from one sector to the other.

Since one of the factors is mobile production of F and M are determined by the allocation of labor.

To solve for the PPF we use the two production functions and the labor endowment equation. Suppose both sector follow Cobb Douglas technologies of the form

\[
Q_M = F_M(K, L_M) = z_m K^{1/2} L_M^{1/2} \\
Q_F = F_F(T, L_F) = z_F T^{1/2} L_F^{1/2}
\]

First, invert each of the production functions for the labor used in each sector, as

\[
L_M = \left( \frac{q_M}{z_M} \right)^{1/2} \frac{1}{K} \\
L_F = \left( \frac{q_F}{z_F} \right)^{1/2} \frac{1}{T}
\]

Now we can use the labor marker equation to solve for the PPF. Call the solution

\[ q_M = P(q_F; K, T) \]
Question: How is the shape of the PPF in the ricardian model?. Why?. What is different here?

A: the difference is the introduction of another factor in the SFM. The curvature of the PPF reflects diminishing marginal return to labor in each sector.

The opportunity cost of M in terms of F is given by the slope of the PPF. If we shift labor from F to M product will increase by $MP_M$. To increase M output for one unit we need labor to increase by $1/ MP_M$. Meanwhile each unit of labor shifted out of F sector will reduce output by $MP_F$. Therefore to increase output in the M sector we need to reduce output in F by $MP_F/MP_M$.

Therefore the slope of the PPF measures the oppor cost of M in terms of F, that is the number of units of F that need to be sacrificed to produced one unit of M is $MP_F/MP_M$.

2.3 Prices, Wages and Labor Allocation

• How much labor will be employed in each sector?. To answer the above question we need to look at supply and demand in the labor market.

Demand for labor:

In each sector, profit-maximizing employers will demand labor up to the point where the value produced by an additional person-hour equals the cost of employing that hour. The demand curve for labor in the manufacturing sector can be written:

$$PM MPL_M = w$$

The wage equals the value of the marginal product of labor in manufacturing. The demand curve for labor in the food sector can be written:

$$PF MPL_F = w$$

The wage rate equals the value of the marginal product of labor in food.
The wage rate must be the same in both sectors, because of the assumption that labor is freely mobile between sectors. The wage rate is determined by the requirement that total labor demand equal total labor supply:

\[ L_M + L_F = L \]

- Given \( P_F \) and \( P_F \) (IMPORTANT) we can determine how labor is allocated between the two sectors.

At the production point the production possibility frontier must be tangent to a line whose slope is minus the price of manufactures divided by that of food. Relationship between relative prices and output:

\[ \frac{MPL_F}{MPL_M} = -\frac{P_M}{P_F} \]

What happens to the allocation of labor and the distribution of income when the prices of food and manufactures change?

*Case i) An equal proportional change in prices:*
When both prices change in the same proportion, no real changes occur. The wage rate \((w)\) rises in the same proportion as the prices, so real wages (i.e. the ratios of the wage rate to the prices of goods) are unaffected. The real incomes of capital owners and landowners also remain the same.

Case ii) A change in relative prices

- When only \(P_M\) rises, labor shifts from the food sector to the manufacturing sector and the output of manufactures rises while that of food falls. The wage rate \((w)\) does not rise as much as \(P_M\) since manufacturing employment increases and thus the marginal product of labor in that sector falls. As a result \(Q_F\) falls and \(Q_M\) rises.

The Response of Output to a Change in the Relative Price of Manufactures

- Recall the economy produces where PPF is tangent to minus the relative prices \(-P_M/P_F\). Thus an increase in the relative price of M will move production from F to M, causing a move down and to the right along the PPF.
2.4 Determination of relative prices and Income distribution

Determination of relative prices

- Notice that since the relative prices of manufactures $P_M/P_F$ are positive related to the relative quantity of M $Q_M/Q_F$, we can draw a relative supply curve RS.

- To derive the relative supply we use the labor market equilibrium condition.

- Let us continue with our Cobb Douglas example, with the following marginal product as

$$MPL_M = \frac{\partial q_M}{\partial L_M} = \frac{1}{2} z_M K^{1/2} L_M^{-1/2}$$

$$MPL_F = \frac{\partial q_F}{\partial L_F} = \frac{1}{2} z_F T^{1/2} L_F^{-1/2}$$

- Using the equilibrium condition

$$w = P_M MPL_M = P_F MPL_F$$

- we can solve for the relative supply equation

$$\frac{P_M}{P_F} = \left( \frac{z_F}{z_M} \right)^2 \frac{Q_M}{K Q_F}$$

which is upward sloping as expected.

- To close the model suppose preferences are of the DB type as

$$U(c_M, c_F) = c_M^{\beta_M} c_F^{1-\beta_M}$$

which implies the following demand function

$$\frac{c_M}{c_F} = \frac{\beta}{P_M/P_F}$$

and $\beta = \beta_M/(1 - \beta_M)$. 
• Hence labor market equilibrium implies $c_M = q_M$ and $c_F = q_F$ so we can solve for the relative prices as

$$\frac{P_M}{P_F} = \frac{z_F}{z_M} \left( \frac{\beta T}{K} \right)^{1/2}$$

• Suppose $P_F = 1$ is the numeraire.

• The payments to the three factors can be determined as

$$w = P_M MPL_M$$

$$r_K = p_M MPK$$

$$r_T = MPT$$

• With the wage rate we can determine the labor allocation $L_F$ and $L_M$.

• With the rental prices we can determine the allocation of capital and land in each sector.

• Finally, using the production function we can determine output and consumption.

Claim: $0 < \frac{\partial w}{\partial P} < 1$. That is an increase in prices leads to an less than proportional increase in wages.

**Income Distribution after the change in relative prices**

First, what are the groups involved in this economy? A: workers (given by $L$), capital owners (by $K$) and land owners (by $T$)

• Suppose that $P_M$ increases by 10%. Then, *we would expect the wage to rise by less than 10%, say by 5%* (KEY OBSERVATION). What is the economic effect of this price increase on the incomes of the following three groups?.

1. Workers: We cannot say whether workers are better or worse off; this depends on the relative importance of manufactures and food in workers’
consumption. WHY?, notice that wages are gone up, but by less than the increase in $P_F$. Hence, real wages (why do we care about real wages??) in terms of M $w/P_M$ has decreased whereas $w/P_F$ has increased. So without knowing how important this goods are to the consumer we cannot say anything.

2. Owners of capital: They are definitely better off. Why first consider how to calculate the gains for them. In the fig below shows the distribution in the M sector. We know that employer will hire labor up to the point where real wages equals the $MP_M$. The total gain is the total area under the curve up the point $L_M$. (total shaded area). Now the the owners of capital have to pay labor at a wage $w/P_M$, and hence this is the gain to the workers. Whatever is left out are the gains accrued to the capitalists. Hence a reduction in the real wages in term of M increases the gains to the owner of capital.

3. Landowners: They are definitely worse off. Similar argument as before.
3 Trade in the Specific Factor Model

3.1 Assumptions of the model

- Assume that both countries (Japan and Norway) have the same relative demand curve.

- Therefore, the only source of international trade is the differences in relative supply. The relative supply might differ because the countries could differ in:
  1) Technology
  2) Factors of production (capital, land, labor)

3.2 Resources and relative supply

- What are the effects of an increase in the supply of capital stock on the outputs of manufactures and food? A country with a lot of capital and not much land will tend to produce a high ratio of manufactures to food at any given prices. This can be seen from the equilibrium equation

\[
\frac{P_M}{P_F} = \left( \frac{z_F}{z_M} \right)^2 \frac{T}{K} \frac{Q_M}{Q_F}
\]

for a given relative price.

- An increase in the supply of capital would shift the relative supply curve to the right. This raises the demand of labor in the M sector which drives the overall wage rate up. Consequently, output in the M sector goes up and output in the F sector falls.

- An increase in the supply of land would shift the relative supply curve to the left.

- We conclude that an increase in capital would shift the relative supply curve to the right. Accordingly, the increase in the supply of land would increase food output and reduce M output, and the relative supply curve would shift left.
What about the effect of an increase in the labor force?

- The effect on relative output is ambiguous, although both outputs increase.

### 3.3 Trade and Relative Prices

- Suppose that Germany has more capital per worker than Norway, while Norway has more land per worker than Germany. That is
  \[
  \frac{K^N}{T^N} < \frac{K^G}{T^G}
  \]
- According to the previous discussion Germany RS curve will be to the right of the US RS.
- As a result, the pretrade (autarky) relative price of manufactures in Germany is lower than the pretrade relative price in Norway.
  \[
  \frac{P_M}{P_F} = \left( \frac{z_F}{z_M} \right)^2 \frac{T}{K} \frac{Q_M}{Q_F}
  \]
- When they open to trade the world RS will lie between the two autarky RS. International trade leads to a convergence of relative prices. Trade has increase the relative price in Germany and decrease it in the US.

### 3.4 The Pattern of Trade

Or how does the equilibrium level of $P_M/P_F$ translate into a pattern of international trade?
In a country that cannot trade, the output of a good must equal its consumption. In the closed economy we have

\[ D_M = Q_M \]
\[ D_F = Q_F \]

where D’s are consumption levels.

International trade makes it possible for the mix of manufactures and food consumed to differ from the mix produced. Therefore we have

\[ P_M D_M + P_F D_F = P_M Q_M + P_F Q_F \]

which can be rearrange as

\[ \frac{D_F - Q_F}{P_F} = \frac{P_M}{P_F} \frac{(Q_M - D_M)}{Q_M} \]

A country cannot spend more than it earns. As shown in the above equation J’s imports of food are exactly equal to A’s exports and A’s imports of M are exactly equal to its exports of M.

FIGURE: two figures side to side, with Norway and Germany budget constraint, showing their respective imports and exports.

3.5 Income Distribution and gains from trade

To assess the effects of trade on particular groups, the key point is that international trade shifts the relative price of manufactures and food.

Important result
• Trade benefits the factor that is specific to the export sector of each country, but hurts the factor that is specific to the import-competing sectors. Trade has ambiguous effects on mobile factors.

• Could those who gain from trade compensate those who lose, and still be better off themselves? If so, then trade is potentially a source of gain to everyone.

• The fundamental reason why trade potentially benefits a country is that it expands the economy’s choices. This expansion of choice means that it is always possible to redistribute income in such a way that everyone gains from trade.