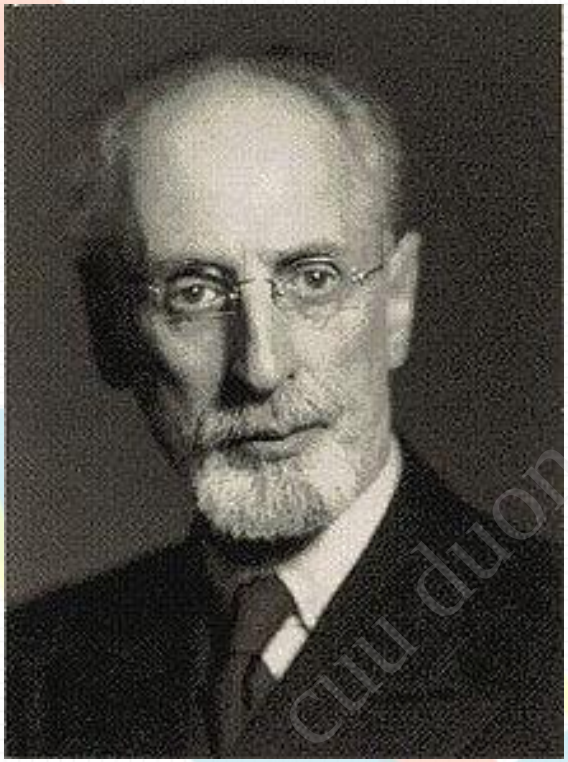
Chapter 4

Factor Endowment, Comparative Advantage and Income Distribution: H – O Model

Contents

- A model of two factor economy
- Trade in the Heckscher-Ohlin Model
- Effects of International Trade between two – Factor Economies
- Empirical evidence on the Heckscher-Ohlin Model

Two Factor Heckscher – Ohlin Model



Eli Heckscher
(1879-1952)

Bertil Ohlin
(1899-1979)

Assumptions

1. Only two countries are modeled: Domestic and Foreign
2. Labor and land are resources important for production.
3. Only two goods are important for production and consumption: cloth and food.
4. The amount of labor and land varies across countries, and this variation influences productivity.
5. The supply of labor and land in each country is constant.
6. Competition allows factors of production to be paid a “competitive” wage/rate, a function of their productivities and the price of the good that it produces, and allows factors to be used in the industry that pays the highest wage/rate.
7. Technology is identical
8. Tastes and preferences are the same
9. Factors are perfectly mobile within a country but immobile between countries
10. No transportation cost and no barrier to trade

Assumptions (cont.)

- In this model, the only difference between the countries is the availability of the factors of production
- Everything else – including the quality of the factors of production – is assumed the same.

Production

- two alternative assumptions:
  - there is only one way to produce each good **(production without factor substitution)**
  - there is a possibility of substituting land for labor and vice versa in production (**production with factor substitution)** => more realistic assumption)

PPF without factor substitution

- Let's expand the previous chapter's model to include two factors of production, labor (L) and land (T).
  - L = total amount of labor available for production
  - T = total amount of land (terrain) available for production
  - a_{LC} = Labor required for each unit of cloth production
  - a_{TC} = Land required for each unit of cloth production
  - a_{LF} = Labor required for each unit of food production
  - a_{TF} = Land required for each unit of food production

PPF without factor substitution (cont.)

- Assume : *each unit* of cloth production uses labor intensively and *each unit* of food production uses land intensively:
  - $a_{LC}/a_{TC} > a_{LF}/a_{TF}$
  - Or $a_{LC}/a_{LF} > a_{TC}/a_{TF}$
- Assume: cloth production is **labor intensive** and food production is **land intensive** if $L_C/T_C > L_F/T_F$.

PPF without factor substitution (cont.)

- Production possibilities are influenced by *both* land and labor (requirements):

$$a_{TF}Q_F + a_{TC}Q_C \leq T$$

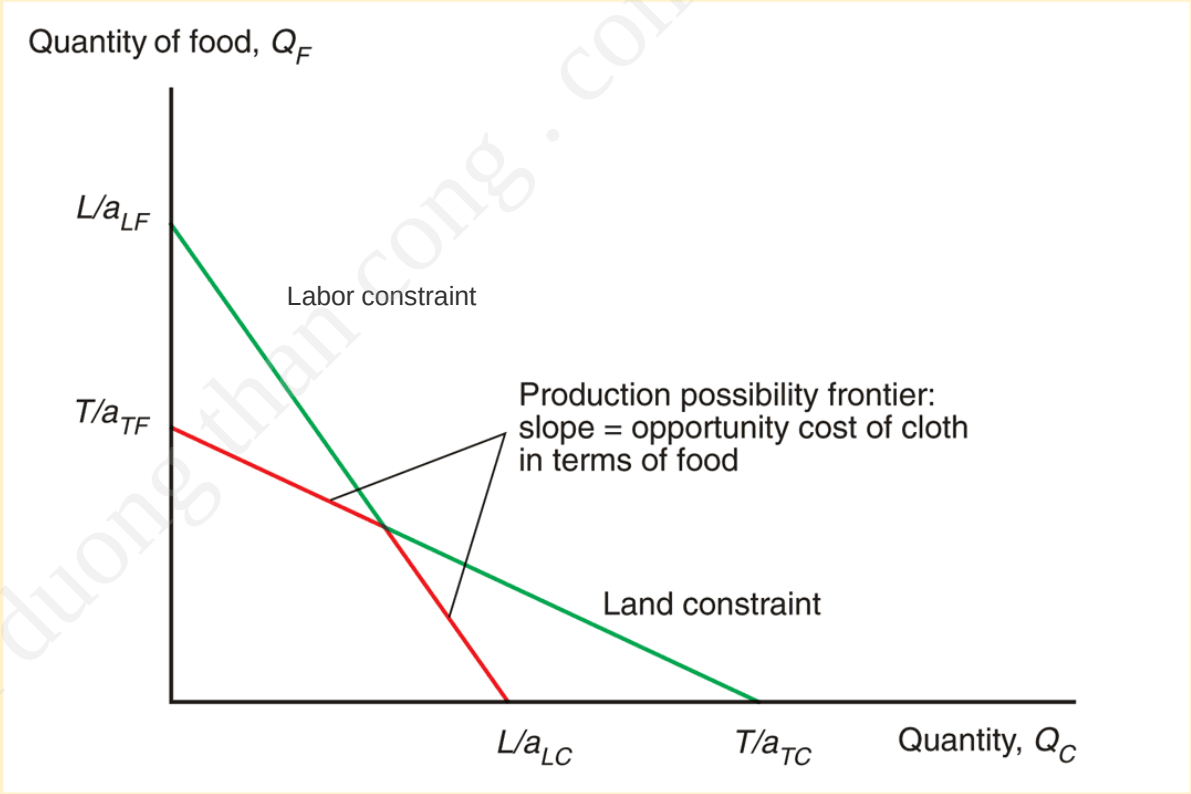
$$a_{LF}Q_F + a_{LC}Q_C \leq L$$

PPF without factor substitution (cont.)

Figure 4-1

The Production Possibility Frontier Without Factor Substitution

If land could not be substituted for labor or vice versa, the production possibility frontier in the factor proportions model would be defined by two resource constraints: The economy can't use more than the available supply of labor or land. So the production possibility frontier is defined by the red line in this figure. The important feature of this frontier is that the opportunity cost of cloth in terms of food isn't constant: It rises as the economy's mix of production shifts toward cloth.



PPF With Factor Substitution

- The above PPF equations do not allow substitution of land for labor in production or vice versa.
  - Unit factor requirements are constant along each line segment of the PPF.
- If we allow substitution of inputs, then the PPF becomes curved.
  - For example, many laborers could work on a small plot of land or a few labors could work on a large plot of land to produce the same amount of output.
  - Unit factor requirements are not constant at *every* quantity of cloth and food produced.

PPF With Factor Substitution (cont.)

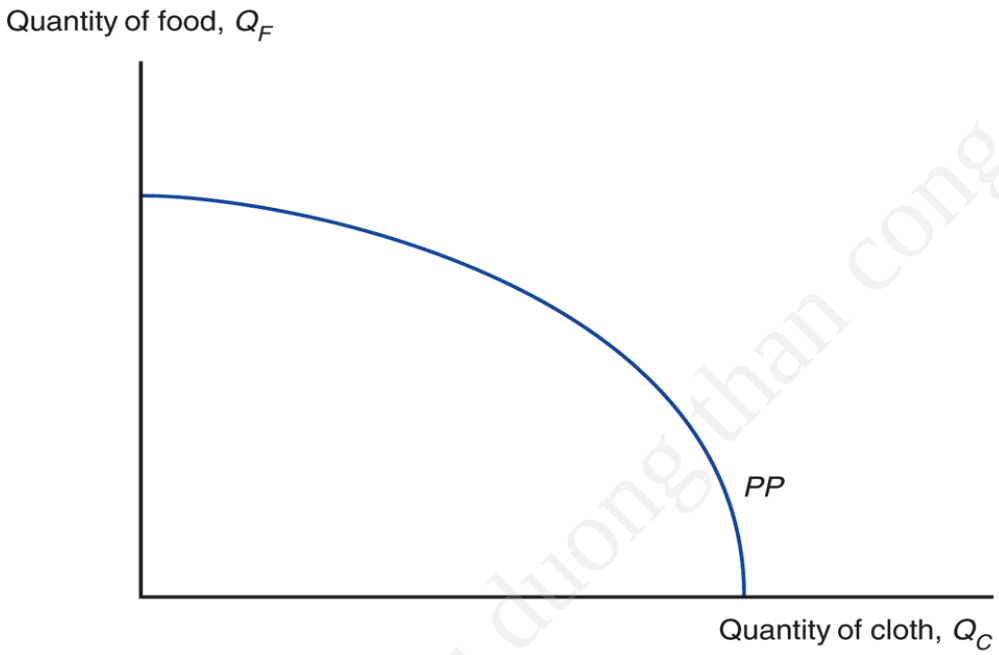


Figure 4-2

The Production Possibility Frontier with Factor Substitution

If land can be substituted for labor and vice versa, the production possibility frontier no longer has a kink. But it remains true that the opportunity cost of cloth in terms of food rises as the economy's production mix shifts toward cloth and away from food.

- PPF has a bowed shape
- OC of producing one more unit of cloth in terms of food rises as the economy produces more cloth and less food

Production and Prices

- PPF: what can produce
- What the economy does produce => must determine the prices of goods.
- In general, the economy should produce at the point that maximizes the value of production, *V:*

$$V = P_C Q_C + P_F Q_F$$

  - where P_C is the price of cloth and P_F is the price of food.

Production and Prices (cont.)

- Define an **isovalue** line as a line representing a constant value of production.
  - $\overline{V} = P_C Q_C + P_F Q_F$
  - $P_F Q_F = \overline{V} - P_C Q_C$
  - $Q_F = \overline{V}/P_F - (P_C/P_F)Q_C$
  - The slope of an isovalue line is $-(P_C/P_F)$

Production and Prices (cont.)

- Given prices of output, one isovalue line represents the maximum value of production, say at a point *Q*.
- At that point, the slope of the PPF equals

– (P_C/P_F), so *the opportunity cost of cloth equals the relative price of cloth.*

Production and Prices (cont.)

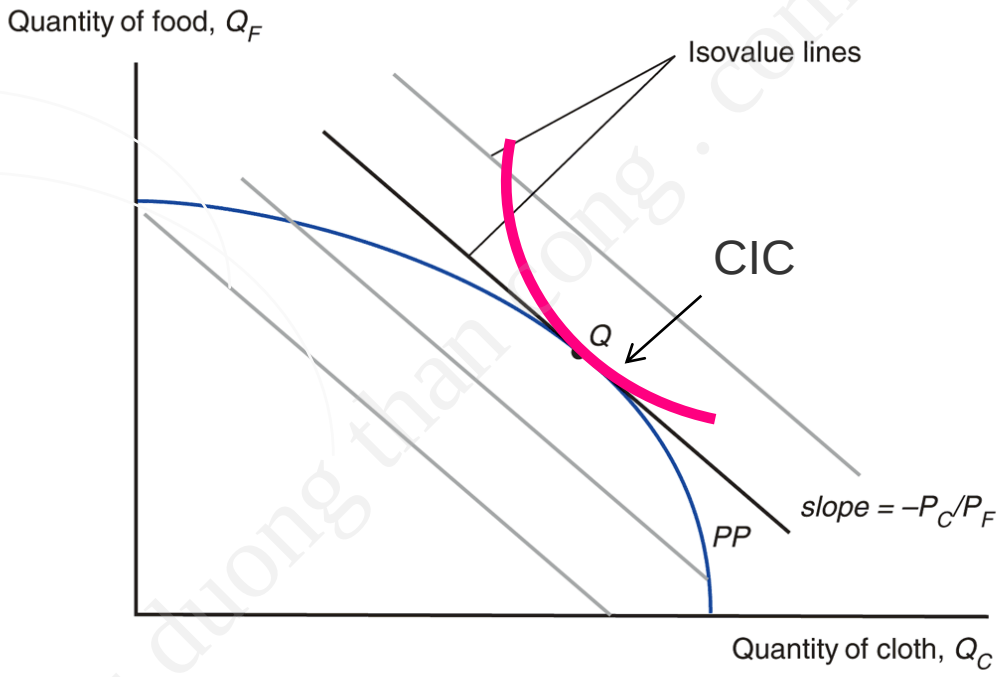


Figure 4-3

Prices and Production

The economy produces at the point that maximizes the value of production given the prices it faces; this is the point that is on the highest possible isovalue line. At the point, the opportunity cost of cloth in terms of food is equal to the relative price of cloth, P_C/P_F.

Input Possibilities

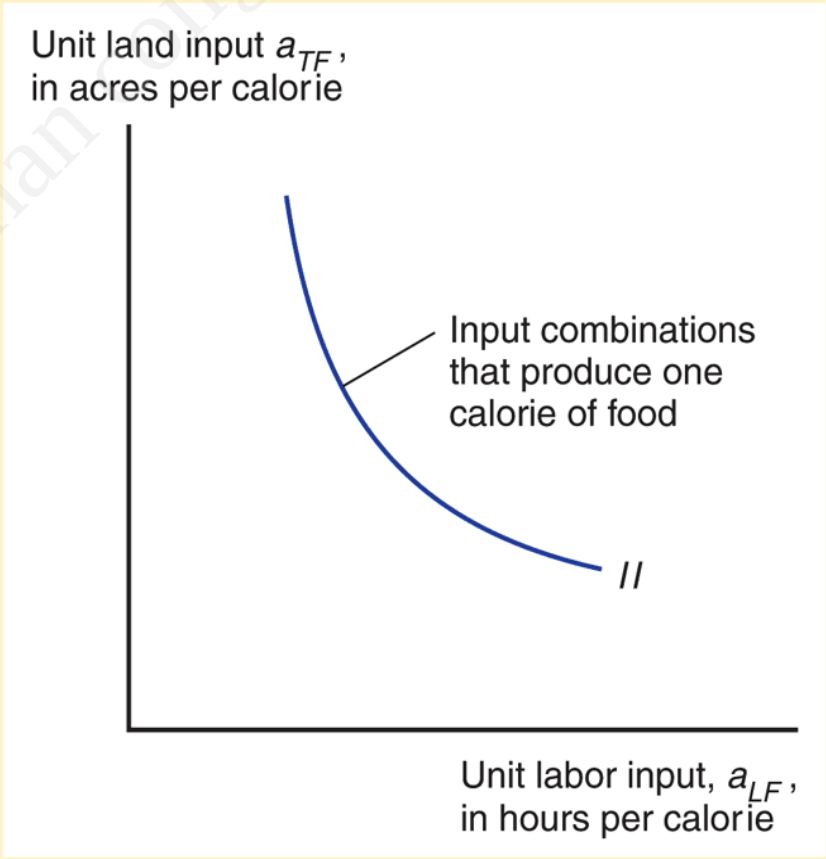
- When we allow the possibility of substituting land for labor and vice versa => room for choice in the use of inputs => no fixed input requirements as in Ricardian.

Figure 4-4

Input Possibilities in Food Production

A farmer can produce a calorie of food with less land if he or she uses more labor, and vice versa.

In the production of each unit of food, unit factor requirements of land and labor are not constant in the Heckscher-Ohlin model



Factor Prices and Factor Levels

- Cost of labor = wage rate: *w*
- Cost of land = land rents: *r*

Factor price

- w/r: ratio of two factor prices
- The choice of input mix depends on the relative cost of land and labor.
- As w/r increases
  - Use more land and less labor in the production of food and cloth.

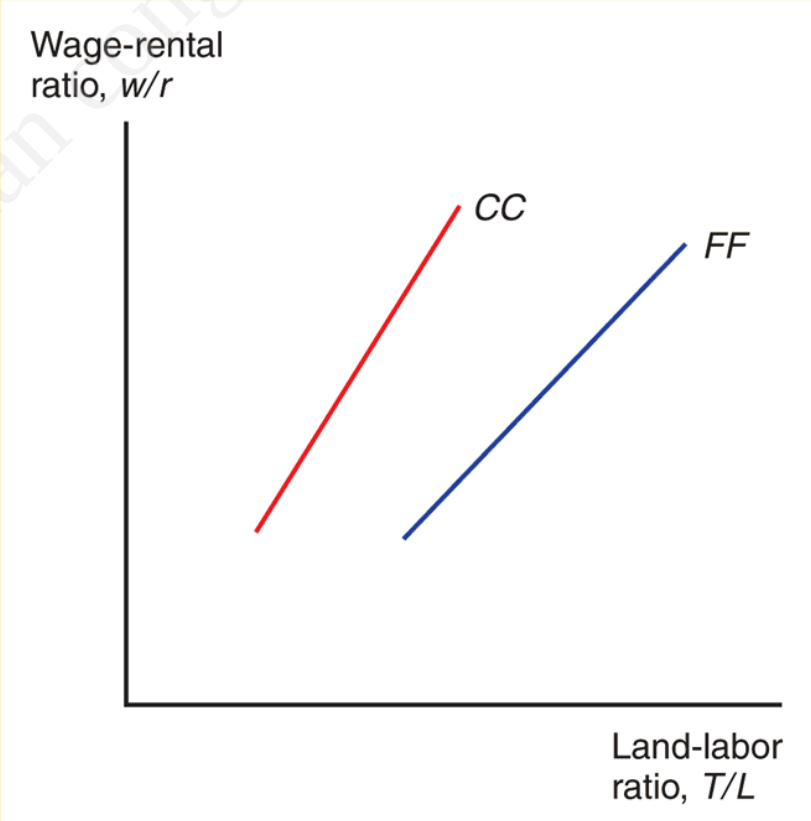
Factor Prices and Factor Levels (cont.)

The choice of input mix depends on the relative cost of land and labor.

Figure 4-5

Factor Prices and Input Choices

In each sector, the ratio of land to labor used in production depends on the cost of labor relative to the cost of land, *w/r*. The curve *FF* shows the land-labor ratio choices in food production, the curve *CC* the corresponding choices in cloth production. At any given wage-rental ratio, food production uses a higher land-labor ratio; when this is the case, we say that food production is *land-intensive* and that cloth production is *labor-intensive*.



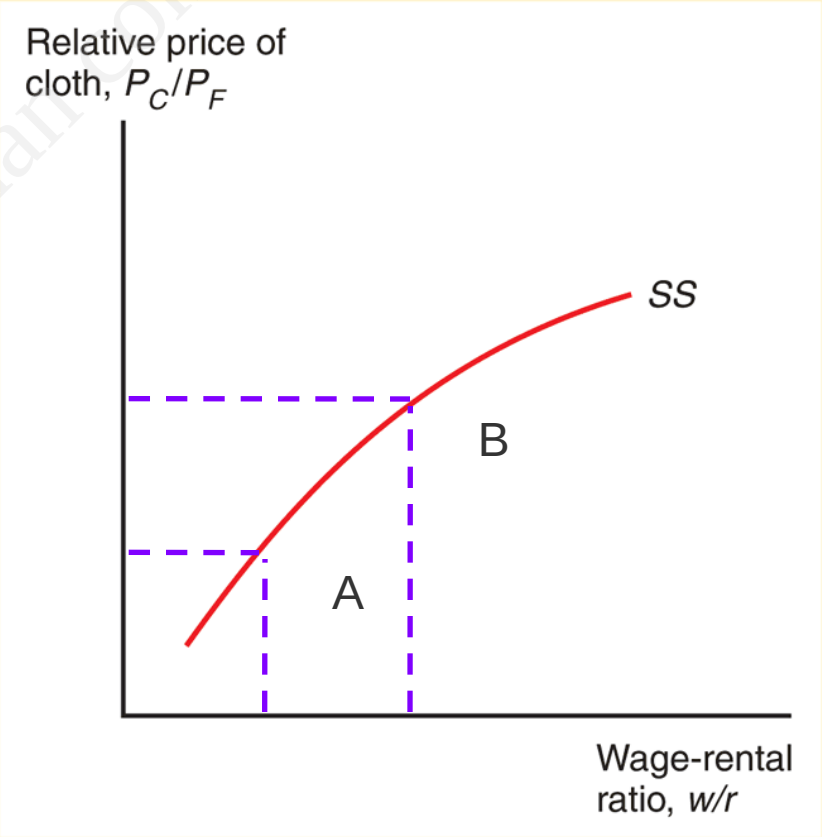
Factor Prices and Goods Prices

- Cloth is labor intensive; Food is land intensive;
- More food and less cloth is produced.
- Under competition, changes in *w/r* are therefore *directly related* to changes in P_C/P_W .

Figure 4-6

Factor Prices and Goods Prices

Because cloth production is labor-intensive while food production is land-intensive, there is a one-to-one relationship between the factor price ratio *w/r* and the relative price of cloth P_C/P_F; the higher the relative cost of labor, the higher must be the relative price of the labor-intensive good. The relationship is illustrated by the curve *SS*.



Factor Prices, Goods Prices and Factor Levels (cont.)

We have a relationship among factor prices and good prices and the levels of factors used in production:

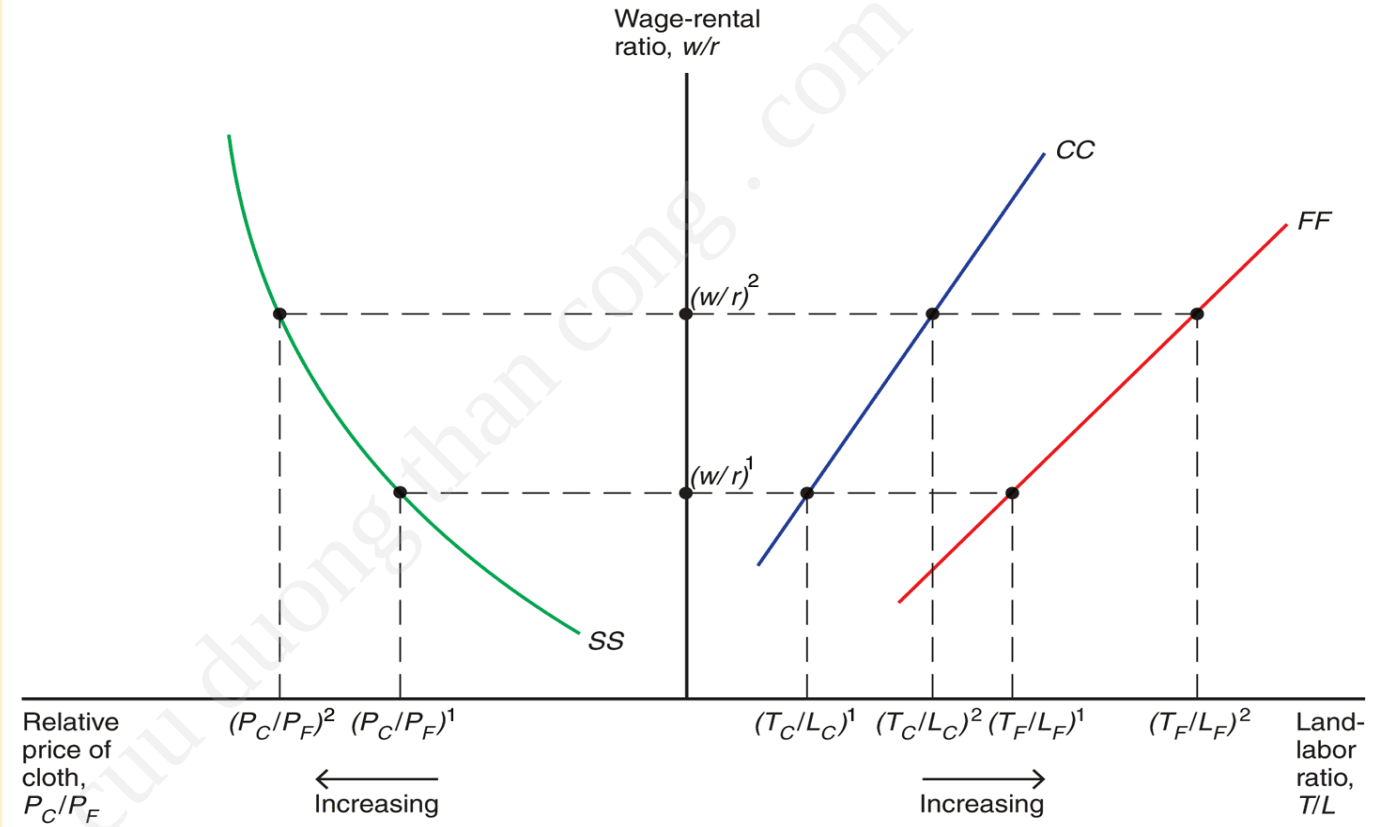


Figure 4-7

From Goods Prices to Input Choices

Given the relative price of cloth $(P_C/P_F)^1$, the ratio of the wage rate to the rental rate on land must equal $(w/r)^1$. This wage-rental ratio then implies that the ratios of land to labor employed in the production of cloth and food must be $(T_C/L_C)^1$ and $(T_F/L_F)^1$. If the relative price of cloth rises to $(P_C/P_F)^2$, the wage-rental ratio must rise to $(w/r)^2$. This will cause the land-labor ratio used in the production of both goods to rise.

Stolper-Samuelson theorem

- If the relative **price** of a good increases, then the real wage or rate of return of the factor used intensively in the production of that good increases, while the real wage or rate of return of the other factor decreases.
- If the relative price of cloth increases

$\Rightarrow$ the wage rate increases, while the rent rate decreases.

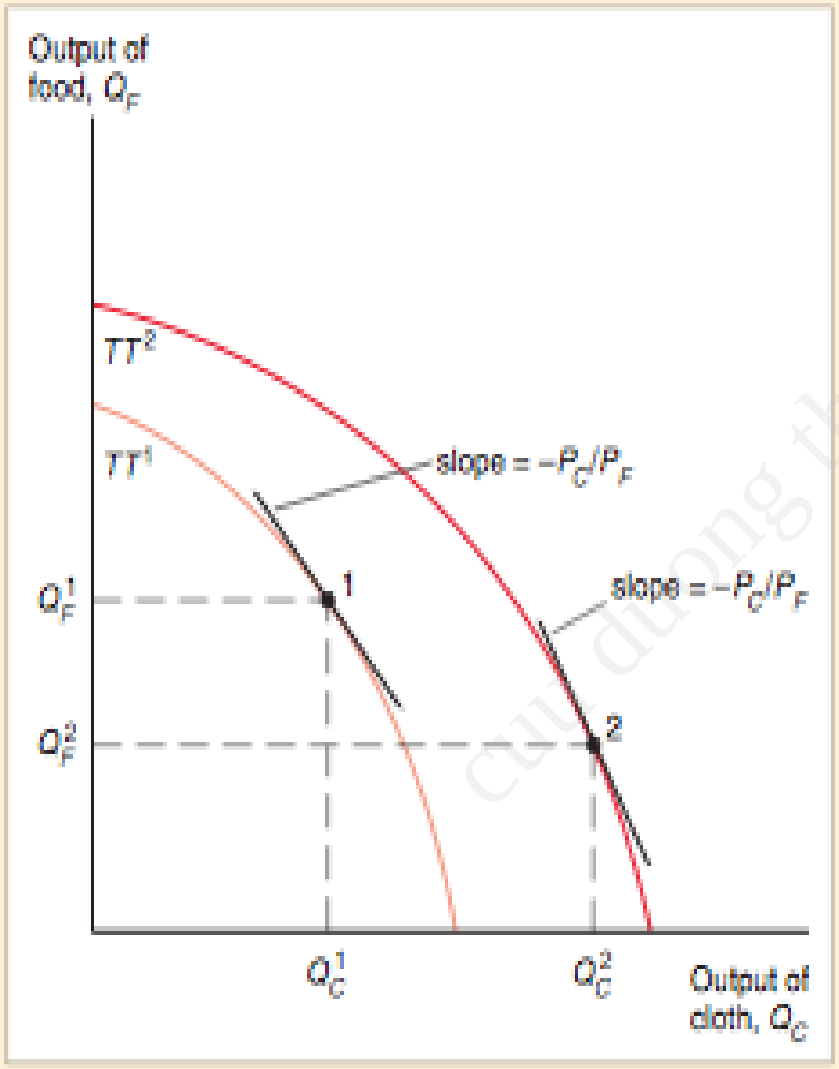
- When the relative prices of goods changes => affect the distribution of income.
  - If the relative prices of cloth increases

  => Raise income of workers relative to that of landowners.

Factor Prices, Goods Prices and Factor Levels (cont.)

- An increase in the relative price of cloth, P_C/P_F , will:
  - raise income of workers relative to that of landowners, *w/r*.
  - raise the ratio of land to labor, *T/L*
  - raise the real income of workers and *lower the real income of land owners*.

Resources and output



Assume: an increase in labor supply; Relative price (P_C/P_F) remains constant

- TT_1: PPF before increase in labor supply
- Production : 1

- TT_2: PPF after the increase in labor supply
- Production point: 2
- There is a **biased expansion of production possibilities,** which occurs when the production possibility frontier shifts out much more in one direction than in the other.

Resources and output (cont.)

- If we hold relative price constant, an increase in supply of labor will result in
  - An increase in output of cloth (labor intensive)
  - A fall in output of food (land intensive)
- If we hold relative price constant, an increase in supply of land will result in
  - An increase in output of food (land intensive)
  - A fall in output of cloth (labor intensive)

Trade in the Heckscher-Ohlin Model

Trade in the Heckscher-Ohlin Model

- Assume:
  - Home is **abundant** in labor
  - Foreign is **abundant** in land:
  - *L/T > L*/ T**
  - Have the same technology and same consumer tastes.
- Because the domestic country is *abundant in labor*, it will be relatively efficient at producing cloth because cloth is *labor intensive*.

Trade in the Heckscher-Ohlin Model (cont.)

- Home is labor abundant and Cloth is a labor intensive good

=>Home will allow a higher ratio of cloth to food

- Foreign is land abundant and Food is a land intensive good

=>Foreign will allow a lower ratio of cloth to food

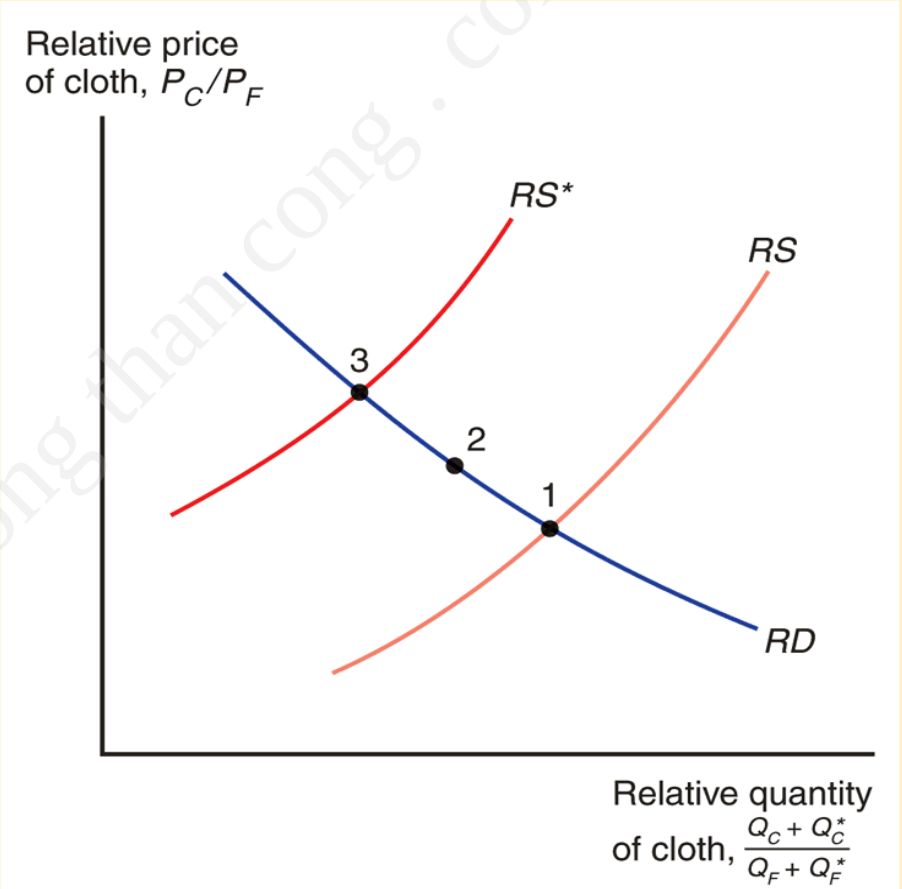
Home will have a higher relative supply of cloth than Foreign

Trade in the Heckscher-Ohlin Model (cont.)

Figure 4-11

Trade Leads to a Convergence of Relative Prices

In the absence of trade, Home's equilibrium would be at point 1, where domestic relative supply *RS* intersects the relative demand curve *RD*. Similarly, Foreign's equilibrium would be at point 3. Trade leads to a world relative price that lies between the pretrade prices, e.g., at point 2.



Trade in the Heckscher-Ohlin Model (cont.)

- With trade, the relative price of cloth will rise in the domestic country and fall in the foreign country.

⇒Home: a rise in the relative production of cloth and a fall in relative consumption of cloth; the domestic country becomes an exporter of cloth and an importer of food.

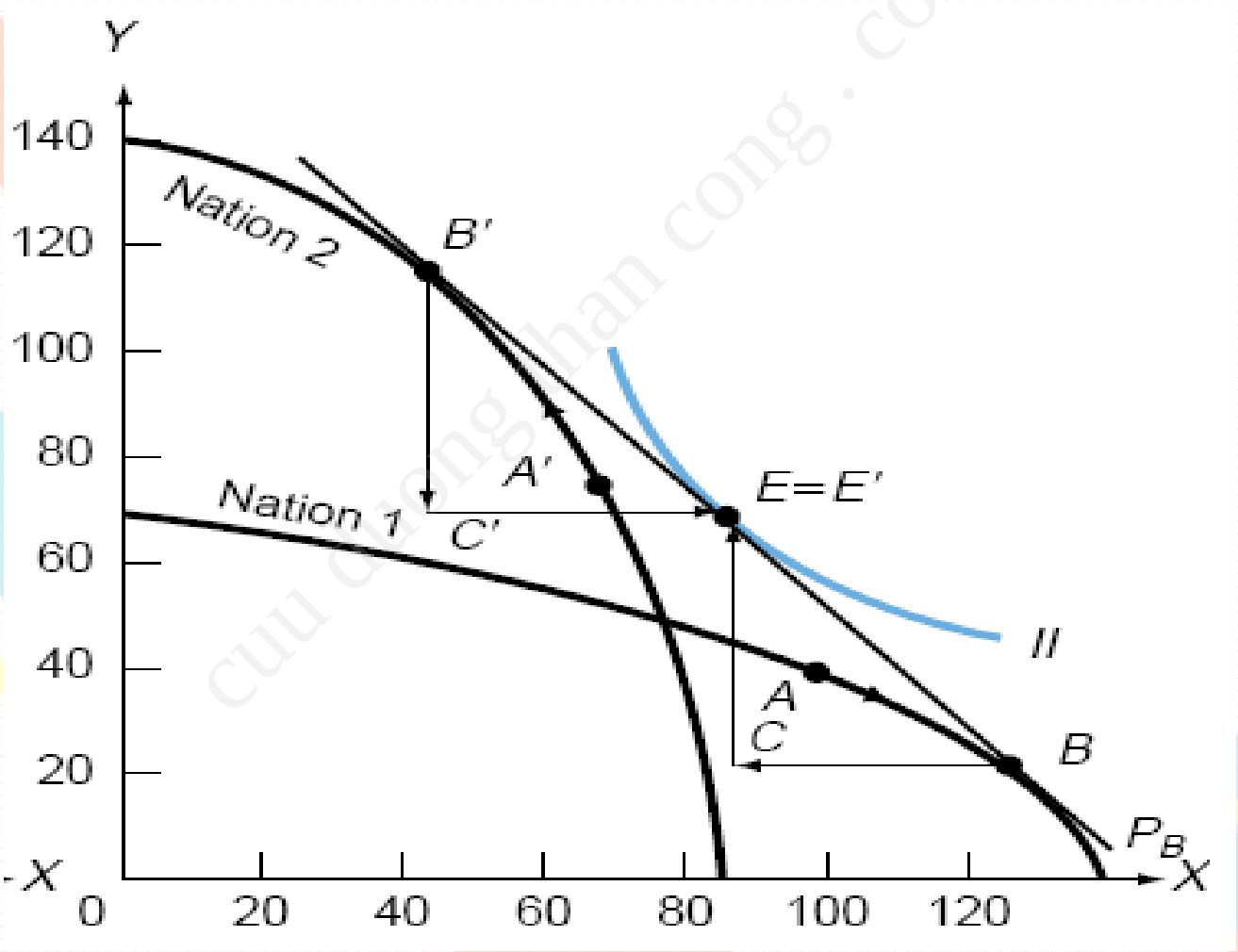
⇒ Foreign: become an importer of cloth and an exporter of food.

H-O theorem

- An economy will be relatively efficient at (have a comparative advantage in) producing goods that are intensive in its abundant factors of production.
- An economy will export goods that are intensive in its abundant factors of production and import goods that are intensive in its scarce factors of production => H-O theorem.

Effects of International Trade between Two – Factor Economies

Trade is good for both countries



Factor Price Equalization – H-O-S theorem

- Unlike the Ricardian model, the Heckscher-Ohlin model predicts that factor prices will be equalized among countries that trade.
  - Relative prices are equalized
  - Direct relationship between relative prices and factor prices
- In autarky: Home - labor abundant, Foreign - capital abundant => w/r < w*/r*
- With trade: w/r = w*/r*
  - Home: exports cloth; Foreign exports food.
  - Relative price of cloth in Home increases => w/r increases
  - Relative price of cloth in Foreign decreases => w*/r* decreases.
  - Until w/r = w*/r*

Factor Price Equalization (cont.)

- The theory of factor price equalization is simple and appealing
- In the real world: factor prices are not really equal across countries.E.g:

TABLE 4-1 Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Production Workers, 2000
United States	100
Germany	121
Japan	111
Spain	55
South Korea	41
Portugal	24
Mexico	12
Sri Lanka*	2

*1999

Factor Price Equalization (cont.)

- Assumptions
  - Both countries produce both goods
  - Technologies are the same
  - Trade actually equalize the prices of goods in the two countries.
- Countries may produce different goods.
- Different technologies could affect the productivities of factors and therefore the wages/rates paid to these factors.
- Trade barriers and transportation costs may prevent goods prices and factor prices from equalizing.

Trade and income distribution in the short run

- In the short run, after an economy liberalizes trade, factors of production may not quickly move to the industries that intensively use abundant factors.
  - In the short run, the productivity of factors will be determined by their use in their current industry, so that their wage/rate may vary across countries.
- The model predicts outcomes for the long run

Case study: North – South Trade and Income Inequality

- Over the last 40 years:
  - Countries like South Korea, Mexico and China have exported to the US goods intensive in unskilled labor
  - At the same time, income inequality has increased in the US, as wages of unskilled workers have grown slowly compared to those of skilled workers.
- Did the former trend cause the latter trend?

Case study: North – South Trade and Income Inequality (cont.)

- The Heckscher-Ohlin model predicts:
  - Owners of abundant factors will gain
  - Owners of scarce factors will lose.
- But little evidence supporting this prediction exists.

1. According to the model, a change in income distribution occurs through changes in goods prices

- No evidence of a change in the prices of skill-intensive goods relative to prices of unskilled-intensive goods.

Case study: North – South Trade and Income Inequality (cont.)

2. According to the model, the relative factor price should converge
   - Wages of skilled labor have increased more rapidly in Mexico than wages of unskilled labor

3. Even if the model were exactly correct, trade between the US and developing countries is a small fraction of the US economy, so its effects on US prices and wages prices should be small.

$\Rightarrow$ Trade is not responsible for the growing gap between skilled and unskilled labor in the US.

Trade and Income Distribution

- 3 main reasons why economists do not generally stress the income distribution effects of trade:
  - Income distribution effects are not specific to international trade
  - It would always be better to compensate the losers from trade (or any economic change) than prohibit trade.
  - There is a political bias in trade politics: potential losers from trade are better politically organized than the winners from trade.

Empirical Evidence of the Heckscher-Ohlin Model

- Wassily Leontief (winner of prize in 1973) study published in 1953.
  - **Leontief paradox**

TABLE 4-2 Factor Content of U.S. Exports and Imports for 1962

	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

Source: Robert Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review* 61 (March 1971), pp. 126–145.

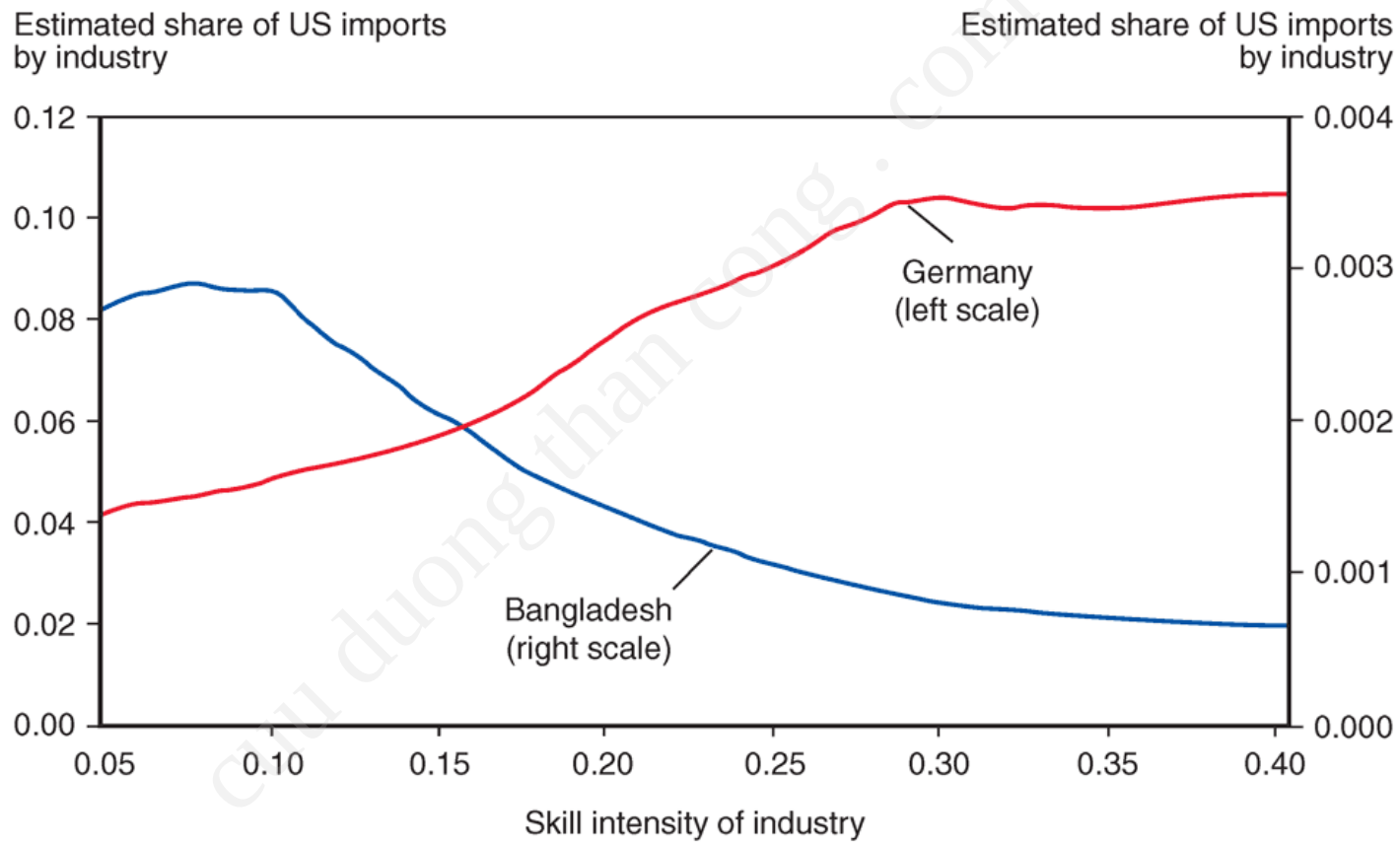
Empirical Evidence of the Heckscher-Ohlin Model (cont.)

- Why do observe the Leontief paradox?
  - The US has a special advantage in producing new products made with innovative technology.
  - Such products may well be less capital intensive than products.
  - Thus the US may be exporting goods that heavily use skilled labor and innovative entrepreneurship, while importing the heavy manufactured products such as automobiles that use large amount of capital.

Empirical Evidence of the Heckscher-Ohlin Model (cont.)

- Tests on global data
  - Bowen, Leamer, and Sveikauskas
  - They confirmed the Leontief paradox on an international level.
- Tests on manufacturing data between low/middle income countries and high income countries.
  - This data do fit the theory quite well.

Fig. 4-15: Skill Intensity and the Pattern of U.S. Imports from Two Countries

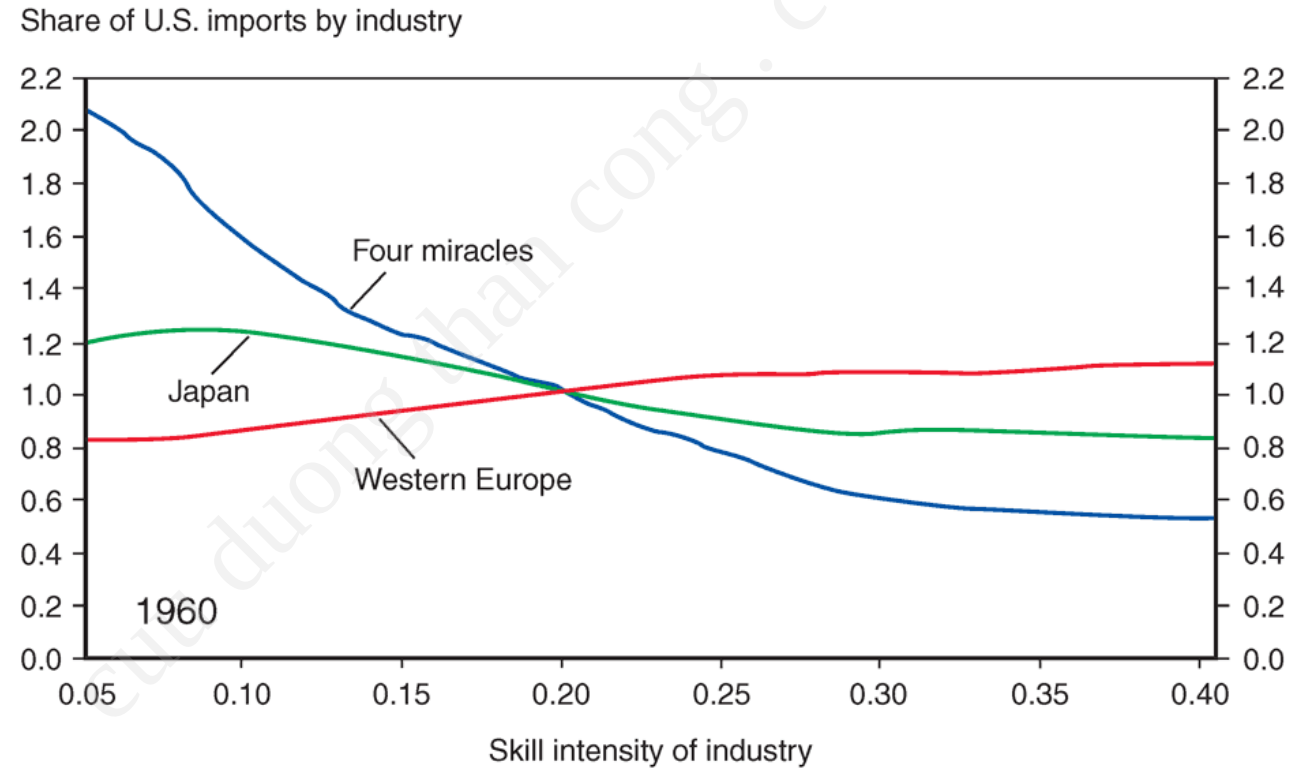


Source: John Romalis, "Factor Proportions and the Structure of Commodity Trade," *American Economic Review*, March 2004.

Empirical Evidence of the Heckscher-Ohlin Model (cont.)

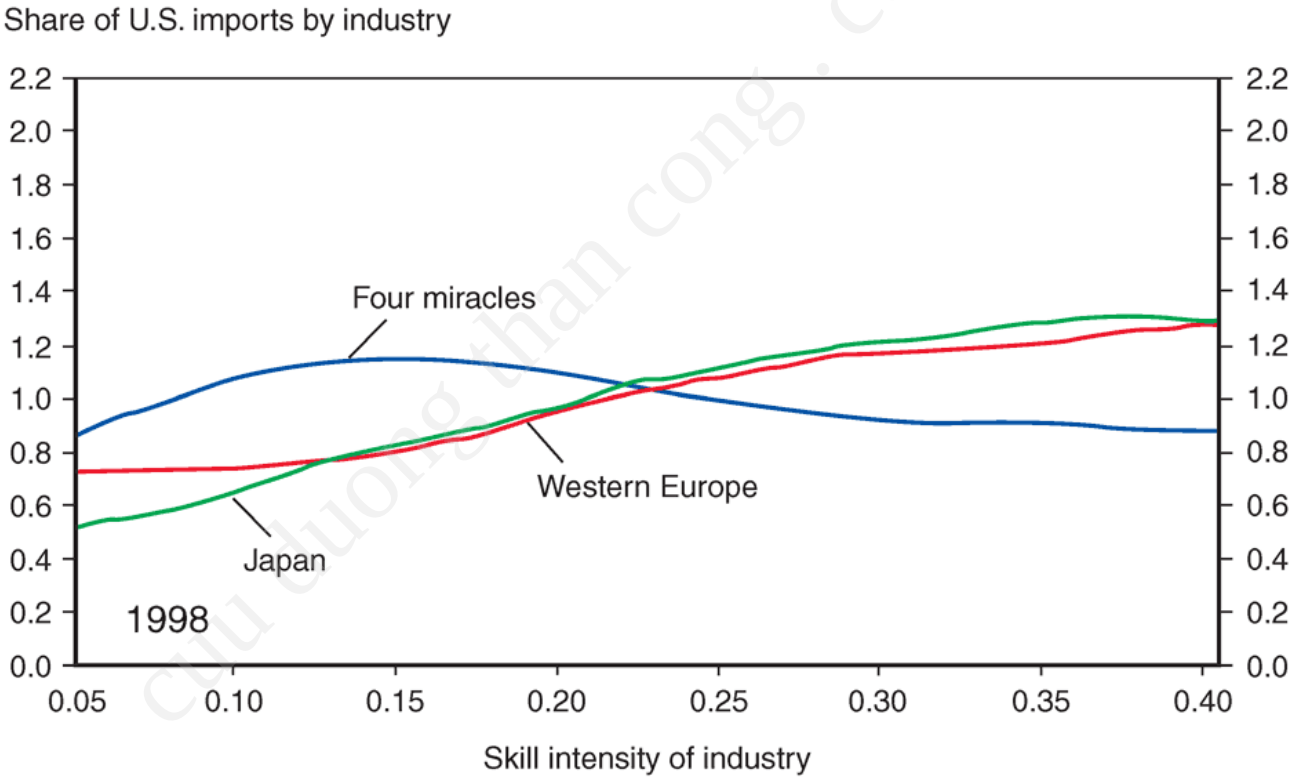
- Changes over time also follow the predictions of the H-O model.

Fig. 4-16.a - Changing Patterns of Comparative Advantage



(a) 1960

Fig. 4-16.b - Changing Patterns of Comparative Advantage (continued)



(a) 1998

Summary

1. Substitution of factors in the production process generates a curved PPF.
   - When an economy produces a low level of a good, the opportunity cost of producing that good is low.
   - When an economy produces a high level of a good, the opportunity cost of producing that good is high.
2. When an economy produces on its PPF, the opportunity cost of producing a good equals the relative price of that good.

Summary (cont.)

3. If the relative price of a good increases, then the real wage or rate of return of the factor used intensively in the production of that good increases, while the real wage or rate of return of the other factor decreases.
4. If we hold output prices constant as a factor of production increases, then the supply of the good that uses this factor intensively increases, and the supply of the other good decreases.

Summary (cont.)

5. An economy will export goods that are intensive in its abundant factors of production and import goods that are intensive in its scarce factors of production.
6. The Heckscher-Ohlin model predicts that relative output prices and factor prices will equalize, neither of which occurs in the real world.
7. The model predicts that owners of abundant factors gain, but owners of scarce factors lose with trade.

Summary (cont.)

8. A country as a whole will be better off with trade, even though the model predicts that owners of scarce factors will be worse off without compensation.
9. Empirical support of the Heckscher-Ohlin model is weak except for cases involving trade between high income countries and low/middle income countries.

END OF CHAPTER 4