KRUGMAN ◆ OBSTFELD

INTERNATIONAL

Theory & Policy

ECONOMICS

8

Chapter 4

Resources, Comparative Advantage, and Income Distribution

PEARSON

Addison
Wesley

Preview

- Production possibilities

- Relationship among output prices, input (factor) prices, and levels of inputs

- Relationship among output prices, input prices, levels of inputs, and levels of output.

- Trade in the Heckscher-Ohlin model

- Factor price equalization

- Income distribution and income inequality

- Empirical evidence

Introduction

- While trade is partly explained by differences in labor productivity, it also can be explained by differences in resources across countries.

- The Heckscher-Ohlin theory argues that differences in labor, labor skills, physical capital, land or other factors of production across countries create productive differences that explain why trade occurs.

  ◆ Countries have a *relative abundance* of factors of production.

  ◆ Production processes use factors of production with *relative intensity*.
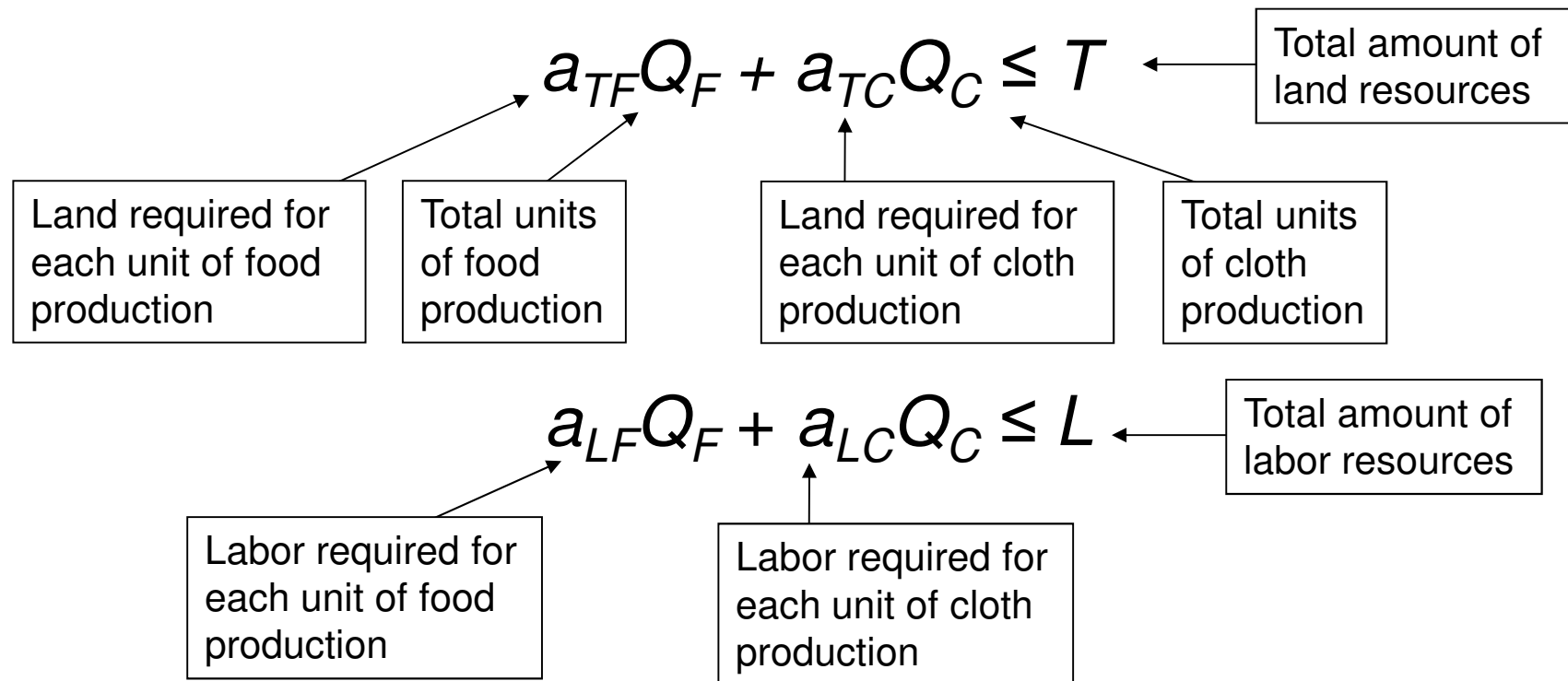
Two Factor Heckscher-Ohlin Model

1. Labor services and land are the resources important for production.

2. The amount of labor services and land varies across countries, and this variation influences productivity.

3. The supply of labor services and land in each country is constant.

4. Only two goods are important for production and consumption: cloth and food.

5. Competition allows factors of production to be paid a "competitive" wage, a function of their productivities and the price of the good that they produce, and allows factors to be used in the industry that pays the most.

6. Only two countries are modeled: domestic and foreign

Production Possibilities

- When there is more than one factor of production, the opportunity cost in production is no longer constant and the PPF is no longer a straight line. Why?

- Let's expand the previous chapter's model to include two factors of production, labor services and land.

  - a_{TC} = hectares of land used to produce one m^2 of cloth
  - a_{LC} = hours of labor used to produce one m^2 of cloth
  - a_{TF} = hectares of land used to produce one calorie of food
  - a_{LF} = hours of labor used to produce one calorie of food
  - L = total amount of labor services available for production
  - T = total amount of land (terrain) available for production
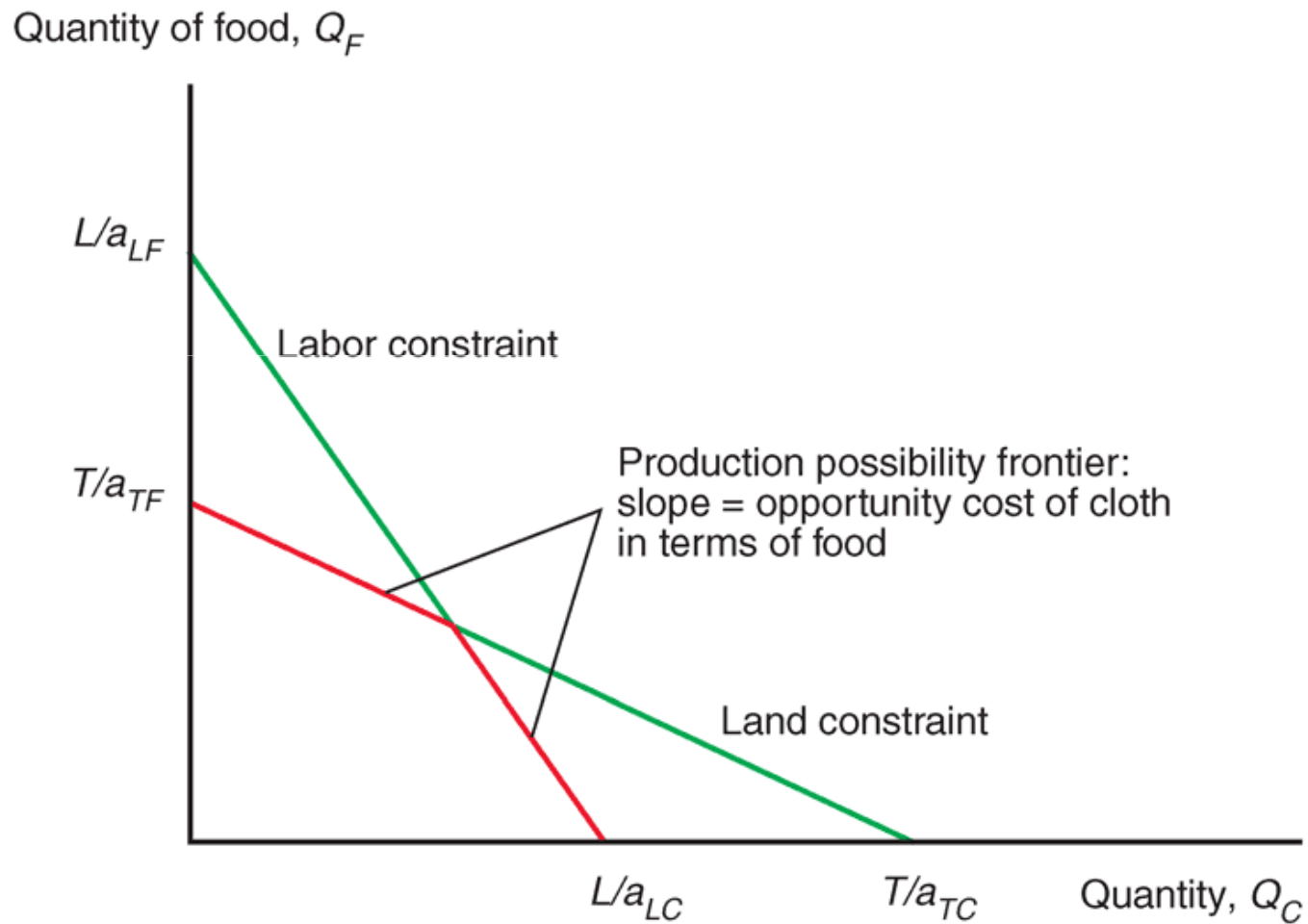
Production Possibilities (cont.)

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

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

Total amount of land resources

Land required for each unit of food production

Total units of food production

Land required for each unit of cloth production

Total units of cloth production

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

Total amount of labor resources

Labor required for each unit of food production

Labor required for each unit of cloth production

Production Possibilities (cont.)

- Let's assume that *each unit* of cloth production uses labor services intensively and *each unit* of food production uses land intensively:

  - ◆ $a_{LC}/a_{TC} > a_{LF}/a_{TF}$

  - ◆ Or $a_{LC}/a_{LF} > a_{TC}/a_{TF}$

  - ◆ Or, we consider the *total* resources used in each industry and say that cloth production is **labor intensive** and food production is **land intensive** if $L_C/T_C > L_F/T_F$.

- This assumption influences the slope of the production possibility frontier:

Fig. 4-1: The Production Possibility Frontier Without Factor Substitution

Production Possibilities (cont.)

- The opportunity cost of producing cloth in terms of food is not constant in this model:

  - ◆ it's *low* when the economy produces a *low amount of cloth* and a high amount of food

  - ◆ it's *high* when the economy produces a *high amount of cloth* and a low amount of food

    - Why? Because when the economy devotes all resources towards the production of a single good, the marginal productivity of those resources tends to be low so that the (opportunity) cost of production tends to be high

      - ◆ In this case, some of the resources could be used more effectively in the production of another good

Production Possibilities (cont.)

- The above PPF equations do not allow substitution of land for labor services in production or vice versa.
  - Unit factor requirements are constant along each line segment of the PPF.

- If producers can substitute one input for another in the production process, then the PPF becomes curved.
  - For example, many workers could work on a small plot of land or a few workers could work on a large plot of land to produce the same amount of output.
  - Unit factor requirements can very at *every* quantity of cloth and food that could be produced.

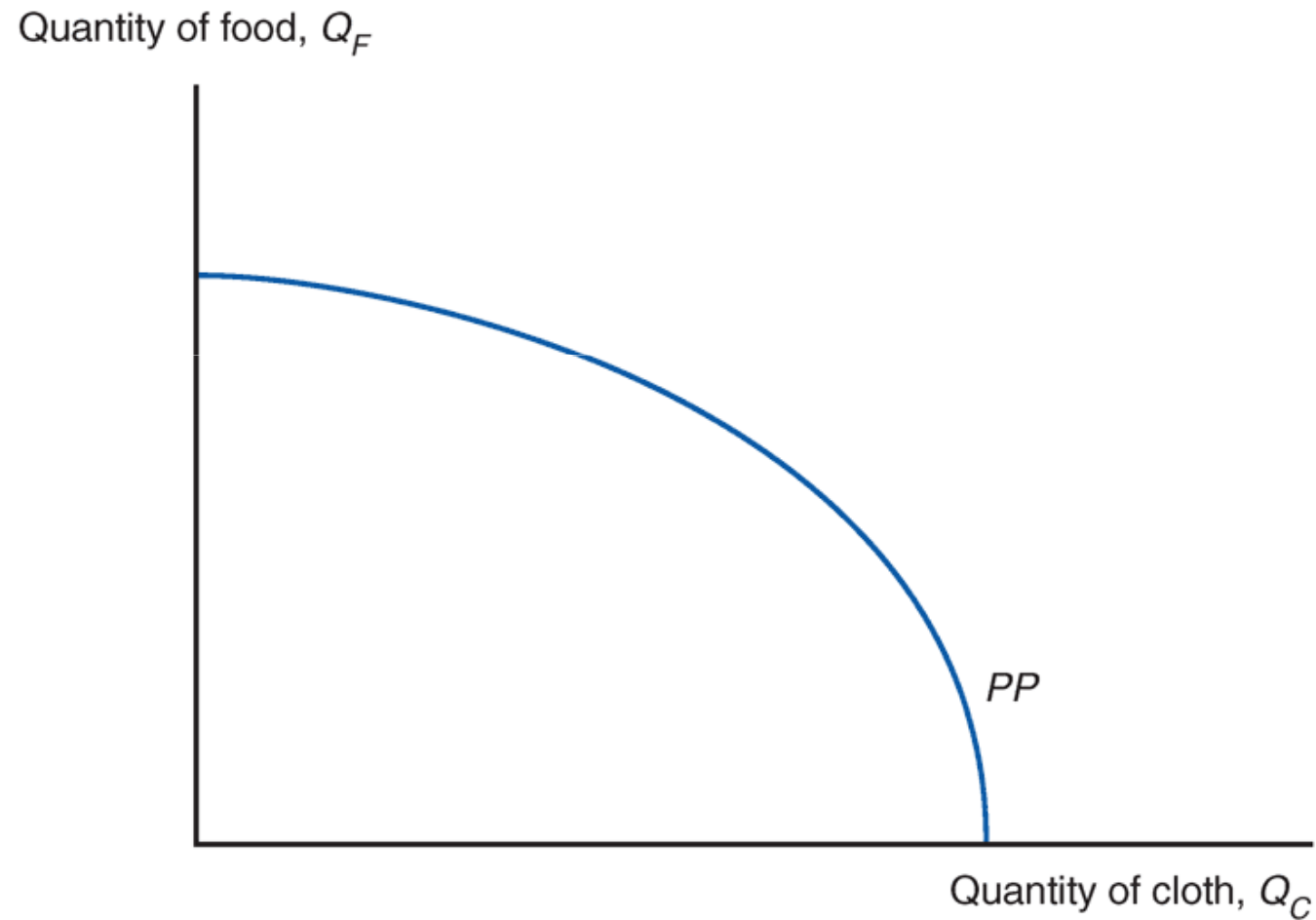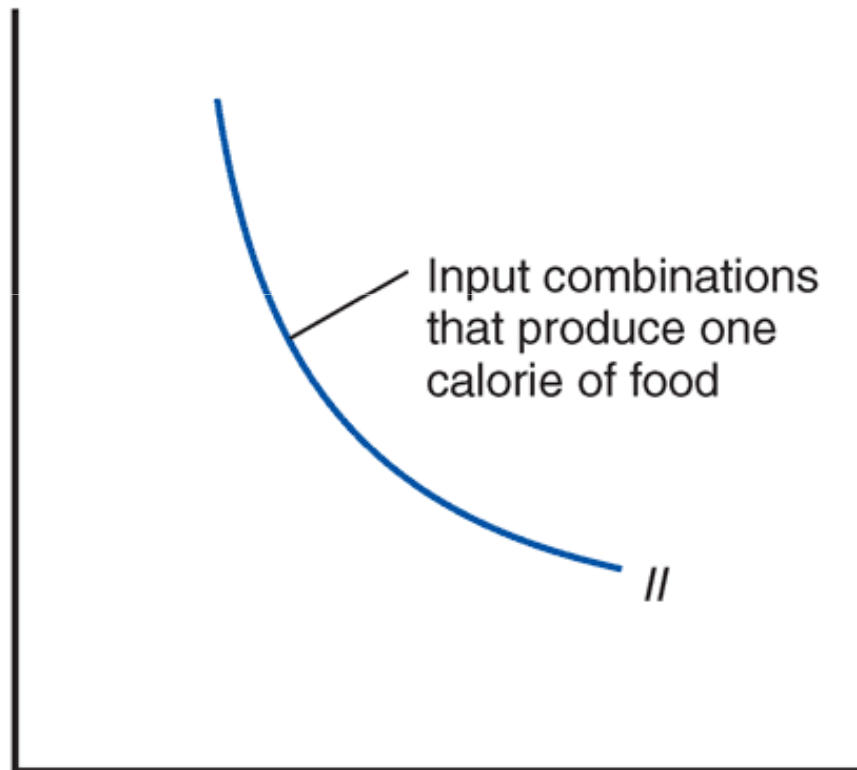# Fig. 4-2: The Production Possibility Frontier with Factor Substitution

Quantity of food, Q_F

PP

Quantity of cloth, Q_C

Fig. 4-4: Input Possibilities in Food Production

Unit land input a_{TF}, in acres per calorie

Input combinations that produce one calorie of food

II

Unit labor input, a_{LF}, in hours per calorie

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

Production and Prices

- The production possibility frontier describes what an economy can produce, but to determine what the economy does produce, we 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, $\overline{V}$.

    - $\overline{V} = P_C Q_C + P_F Q_F$

    - $P_F Q_F = \overline{V} - P_C Q_C$

    - $Q_F = \overline{V}/P_F - (P_C /P_F)Q_C$

    - The slope of an isovalue line is $- (P_C /P_F)$

Fig. 4-3: Prices and Production

Quantity of food, Q_F

Isovalue lines

Q

slope $= -P_C/P_F$

PP

Quantity of cloth, Q_C
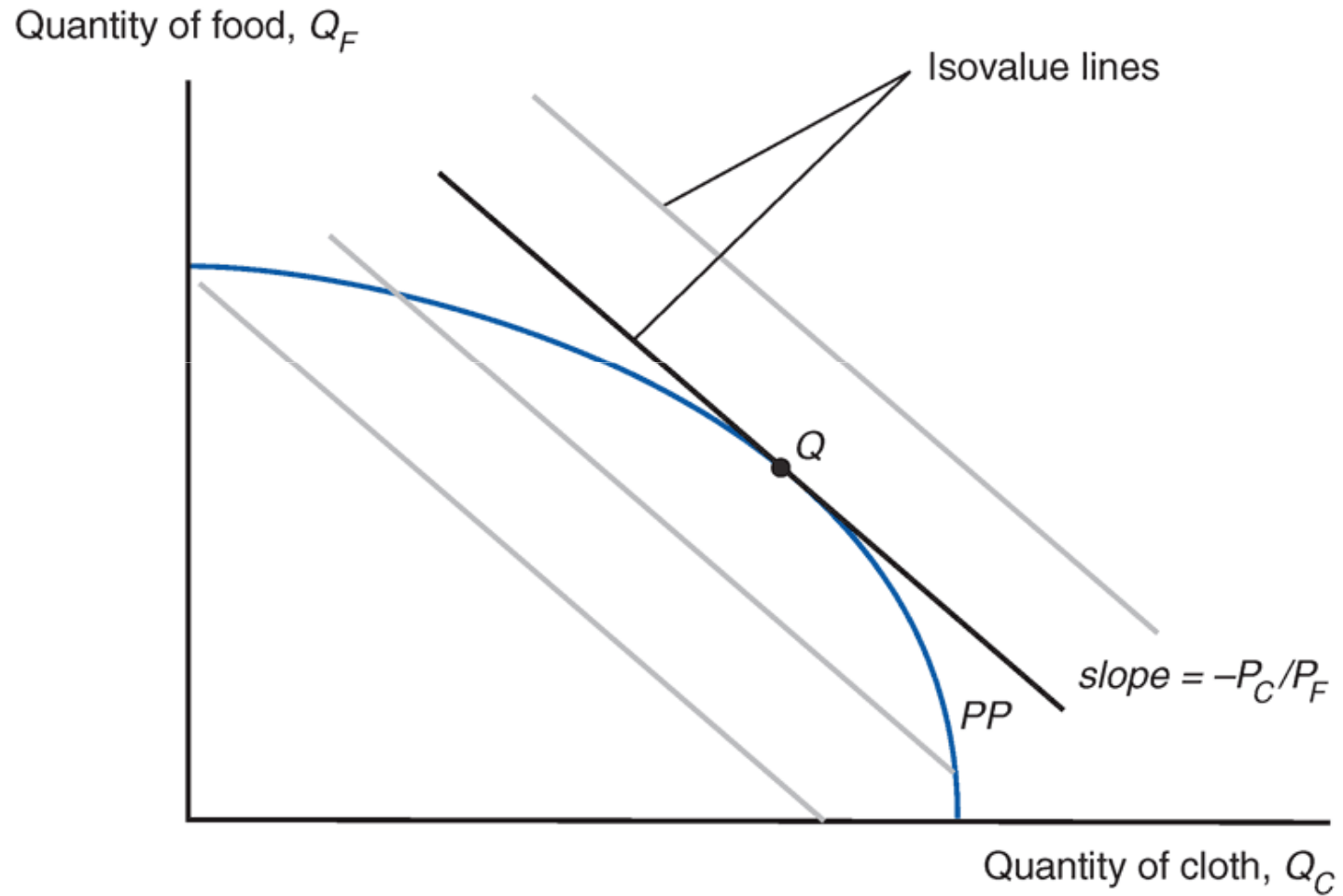
Production and Prices (cont.)

- Given prices of output, a point on 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.*

  - In other words, the trade-off in production equals the trade-off according to market prices.

Factor Prices, Output Prices, and Levels of Factors of Production

- Producers may choose different amounts of factors of production used to make cloth or food.

- Their choice depends on the wage rate, w, and the (opportunity) cost of using land, the rate r at which land can be lent to others or rented from others.

- As the wage rate increases relative to the lending/renting rate r, producers are willing to use less labor services and more land in the production of food and cloth.

  - Recall that food production is land intensive and cloth production is labor intensive.

Fig. 4-5: Factor Prices and Input Choices
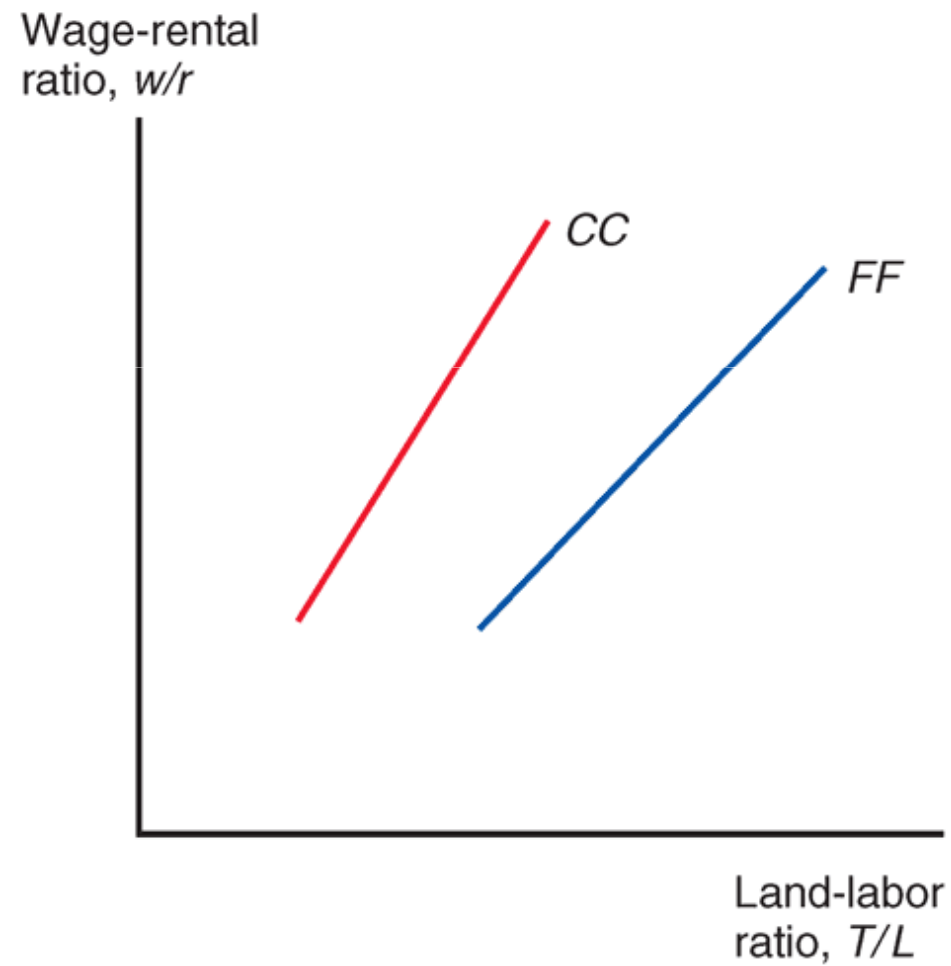
Factor Prices, Output Prices, and Levels of Factors (cont.)

- In competitive markets, the price of a good should be reduced to the cost of production, and the cost of production depends on the wage rate and the lending/renting rate.

- The effect of changes in the wage rate depend on the intensity of labor services in production.

- The effect of changes in the lending/renting rate of land depend on the intensity of land usage in production.
  - An increase in the lending/renting rate of land should affect the price of food more than the price of cloth since food is the land intensive industry.

- With competition, changes in w/r are therefore *directly related* to changes in P_C/P_W.
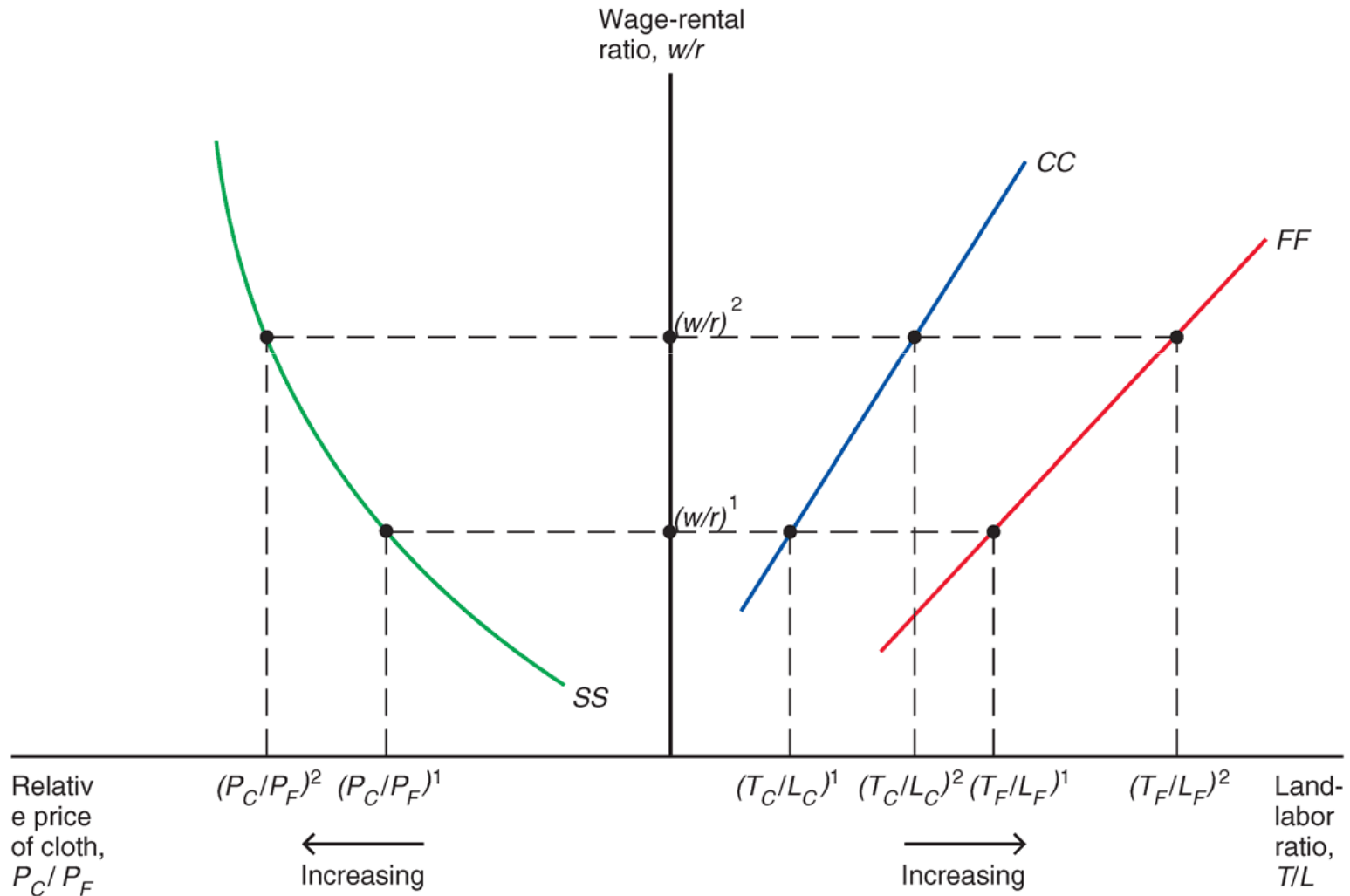
Fig. 4-6: Factor Prices and Goods Prices

Relative price of cloth, P_C/P_F

SS

Wage-rental ratio, w/r

Factor Prices, Output Prices, and Levels of Factors (cont.)

- We have a relationship among input (factor) prices and output prices and the levels of factors used in production:

- **Stolper-Samuelson theorem**: if the relative price of a good increases, then the real wage or real lending/ renting rate of the factor used intensively in the production of that good increases, while the real wage or real lending/renting rate of the other factor decreases.

  - ◆ Under competition, the real wage/rate is equal to the marginal productivity of the factor.
  - ◆ The marginal productivity of a factor typically decreases as the level of that factor used in production increases.

Fig. 4-7: From Goods Prices to Input Choices

Wage-rental ratio, w/r

CC

FF

$(w/r)^2$

$(w/r)^1$

SS

Relative price of cloth, P_C/P_F

$(P_C/P_F)^2$ $(P_C/P_F)^1$

← Increasing

$(T_C/L_C)^1$ $(T_C/L_C)^2$ $(T_F/L_F)^1$ $(T_F/L_F)^2$

Land-labor ratio, T/L

Increasing →

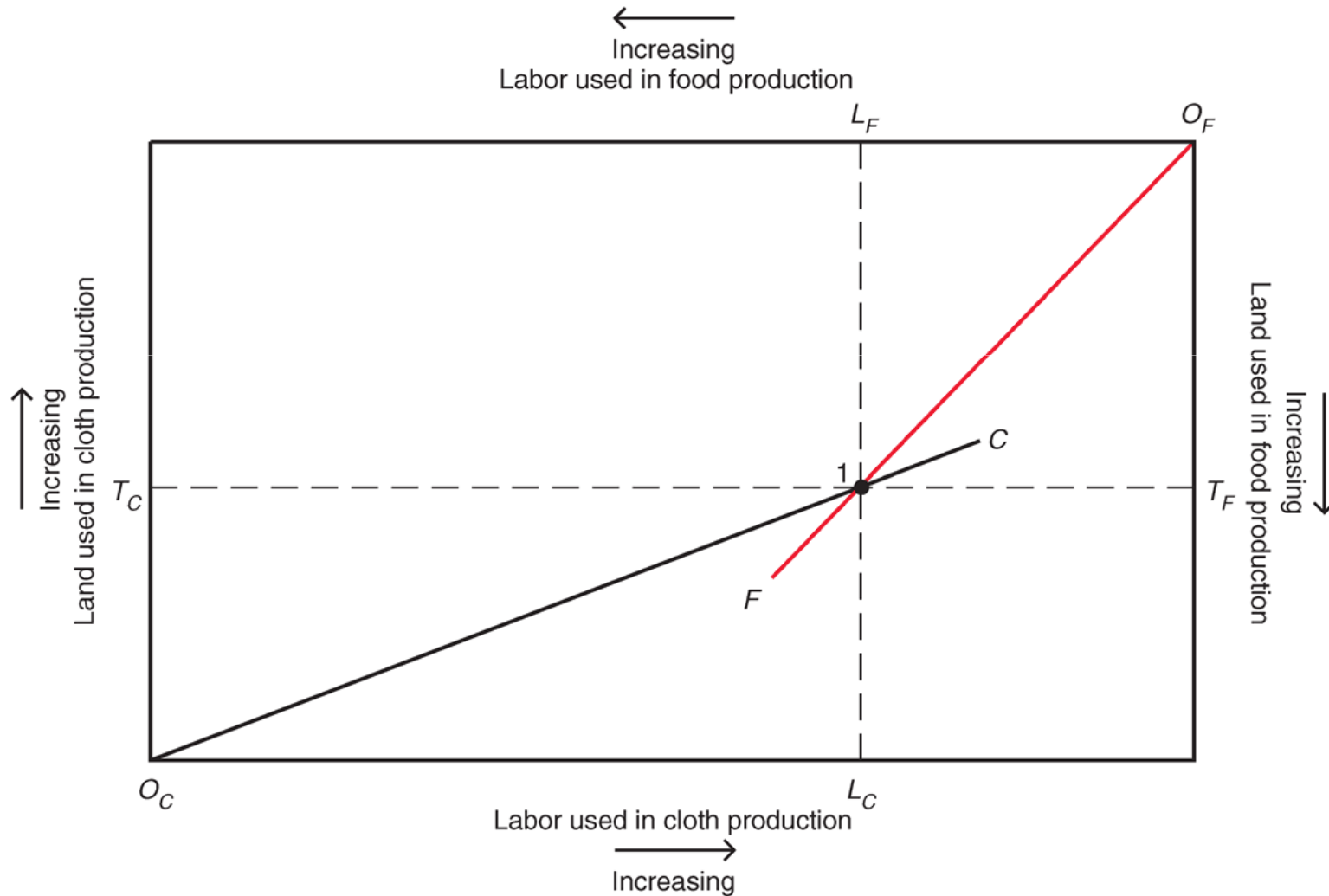# Factor Prices, Output Prices, and Levels of Factors (cont.)

- We have a theory that predicts changes in the distribution of income when the relative price of goods changes, say because of trade.

- An increase in the relative price of cloth, P_C/P_F, is predicted to:
  - ◆ raise income of workers relative to that of landowners, *w/r*.
  - ◆ raise the ratio of land to labor services, *T/L*, used in both industries and raise the marginal productivity of labor in both industries and lower the marginal productivity of land in both industries.
  - ◆ raise the real income of workers and *lower the real income of land owners*.

Factor Prices, Output Prices, Levels of Factors, and Levels of Output

- The allocation of factors used in production determine the maximum level of output (on the PPF).

- We represent the amount of factors used in the production of different goods using the following diagram:

Fig. 4-8: The Allocation of Resources

Factor Prices, Output Prices, Levels of Factors, and Levels of Output

- How do levels of output change when the economy's resources change?

- If we hold output prices constant as the amount of 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*.

  ◆ This proposition is called the Rybczynski theorem.

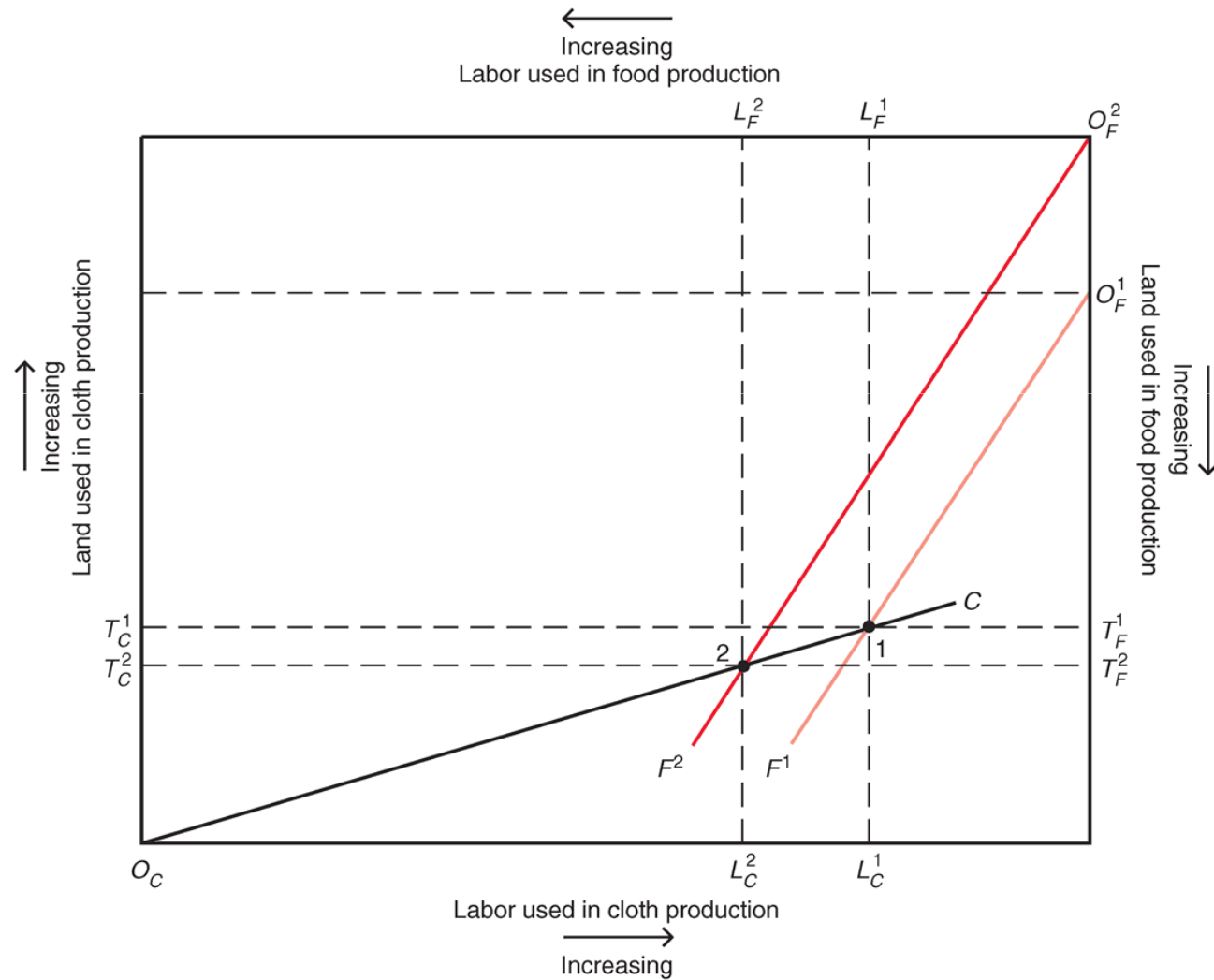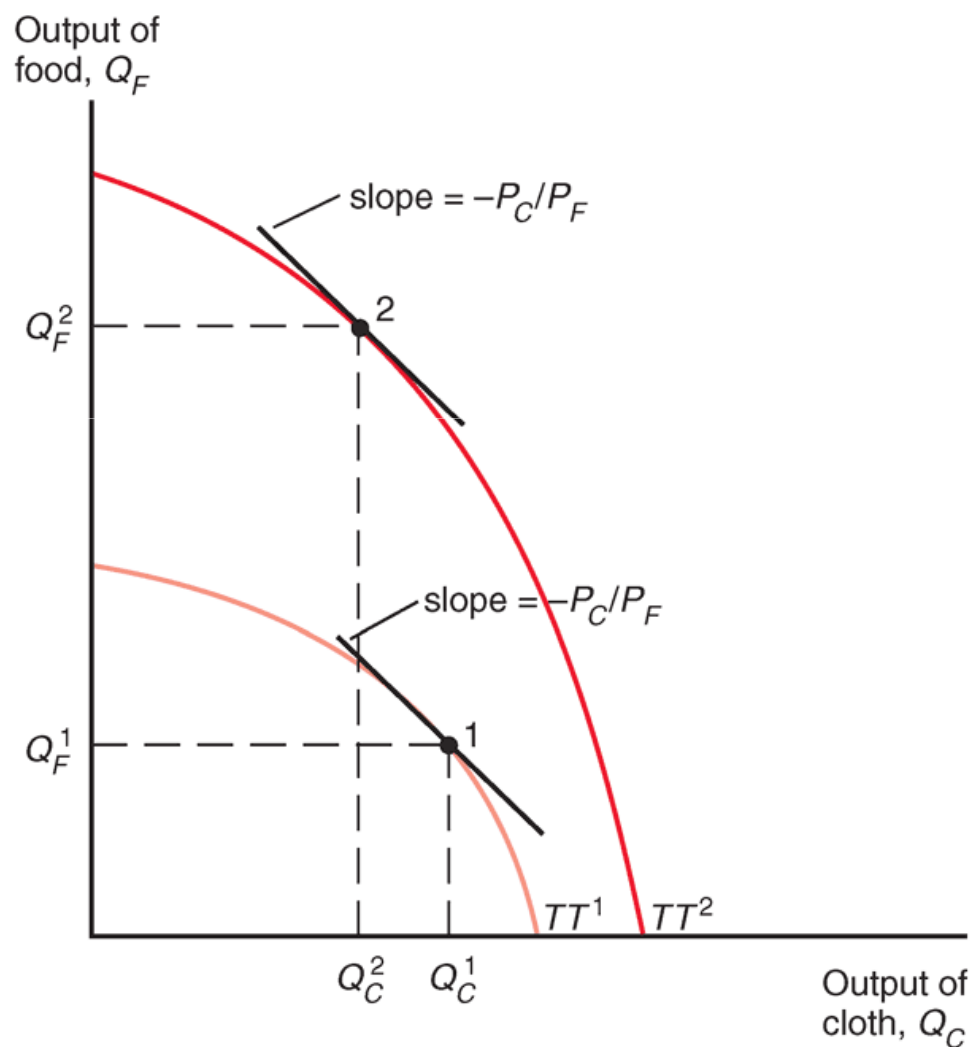# Fig. 4-9: An Increase in the Supply of Land

Fig. 4-10: Resources and Production Possibilities

Factor Prices, Output Prices, Levels of Factors, and Levels of Output

- An economy with a *high ratio of land to labor services* is predicted to have a *high output of food* relative to cloth and a *low price of food* relative to cloth.

  - It will be relatively efficient at (have a comparative advantage in) producing food.

  - It will be relatively inefficient at producing cloth.

- An economy is predicted to be relatively efficient at producing goods that are intensive in the factors of production in which the country is relatively well endowed.
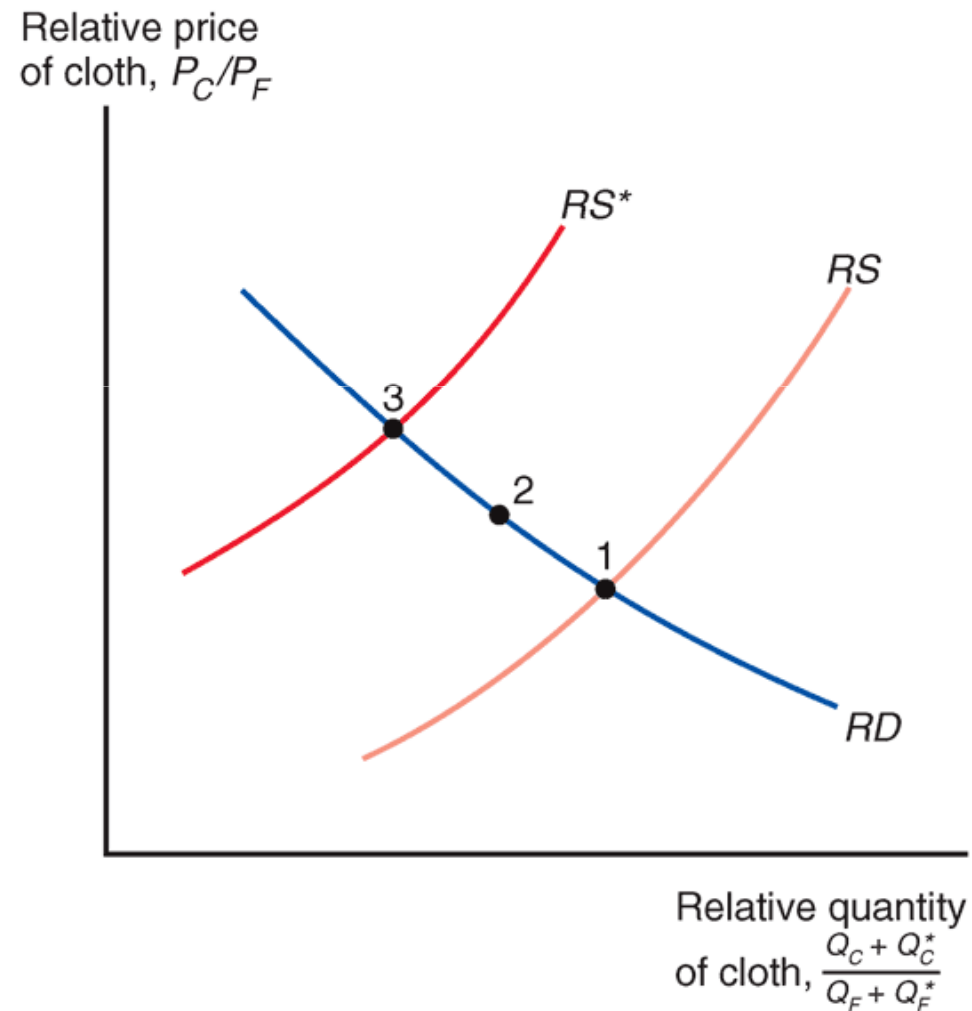
Trade in the Heckscher-Ohlin Model

- Suppose that the domestic country has an abundant amount of labor services relative to land.

  - The domestic country is **abundant** in labor services and the foreign country is **abundant** in land: *L/T > L*/ T**

  - Likewise, the domestic country is **scarce** in land and the foreign country is **scarce** in labor services.

  - However, the countries are assumed to have the same technology and same consumer tastes.

- Because the domestic country is *abundant in labor services*, it will be relatively efficient at producing cloth because cloth is *labor intensive*.

Trade in the Heckscher-Ohlin Model (cont.)

- Since cloth is a labor intensive good, the domestic country's PPF will allow a higher ratio of cloth to food relative to the foreign county's PPF.

- At each relative price, the domestic country will produce a higher ratio of cloth to food than the foreign country.

  ◆ The domestic country will have a higher relative supply of cloth than the foreign country.

Fig. 4-11: Trade Leads to a Convergence of Relative Prices

Trade in the Heckscher-Ohlin Model (cont.)

- Like the Ricardian model, the Heckscher-Ohlin model predicts a convergence of relative prices with trade.

- With trade, the relative price of cloth is predicted to rise in the labor abundant (domestic) country and fall in the labor scarce (foreign) country.

  ◆ In the domestic country, the rise in the relative price of cloth leads to 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.

  ◆ The decline in the relative price of cloth in the foreign country leads it to become an importer of cloth and an exporter of food.

Trade in the Heckscher-Ohlin Model (cont.)

- An economy is predicted to be relatively efficient at (have a comparative advantage in) producing goods that are intensive in its abundant factors of production.

- An economy is predicted to export goods that are intensive in its abundant factors of production and import goods that are intensive in its scarce factors of production.

  - This proposition is called the Heckscher-Ohlin theorem

Trade in the Heckscher-Ohlin Model (cont.)

- Over time, the value of goods consumed is constrained to equal the value of goods produced for each country.

$$P_C D_C + P_F D_F = P_C Q_C + P_F Q_F$$

where D_C represents domestic consumption demand of cloth and D_F represents domestic consumption demand of food

$$(D_F - Q_F) = (P_C/P_F)(Q_C - D_C)$$

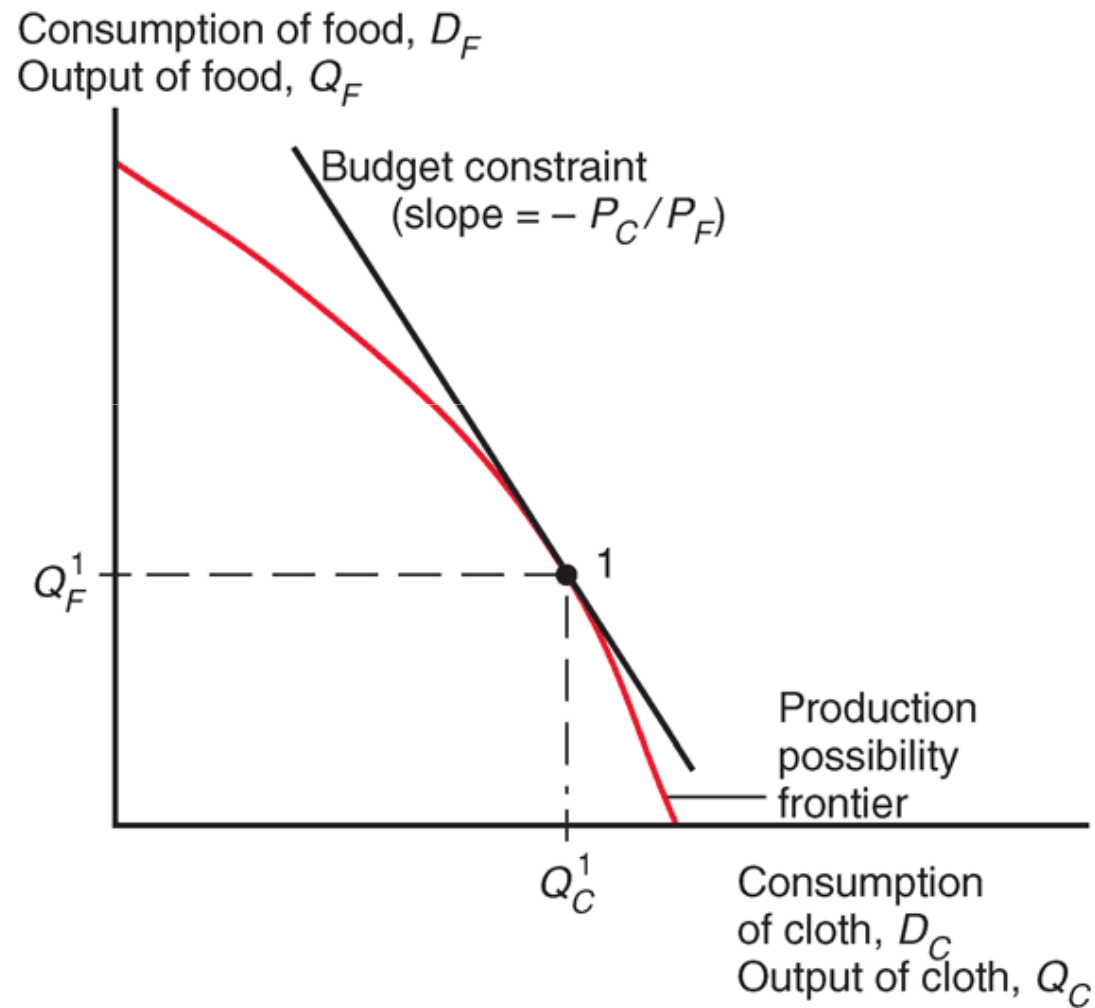| Quantity of imports	Price of exports relative to imports	Quantity of exports

Trade in the Heckscher-Ohlin Model (cont.)

$$(D_F - Q_F) = (P_C/P_F)(Q_C - D_C)$$

- This equation is the *budget constraint* for an economy, and it has a slope of $-(P_C/P_F)$

$$(D_F - Q_F) - (P_C/P_F)(Q_C - D_C) = 0$$

Fig. 4-12: The Budget Constraint for a Trading Economy

Consumption of food, D_F
Output of food, Q_F

Budget constraint
(slope $= -P_C/P_F$)

Q_F^1

1

Production
possibility
frontier

Q_C^1

Consumption
of cloth, D_C
Output of cloth, Q_C

Trade in the Heckscher-Ohlin Model (cont.)

- Note that the budget constraint touches the PPF: a country can always afford to consume what it produces.

- However, a country need not consume only the goods and services that it produces with trade.

  ◆ Exports and imports can be greater than zero.

- Furthermore, a country can afford to consume more of both goods with trade.

Fig. 4-13: Trading Equilibrium

(a) Home

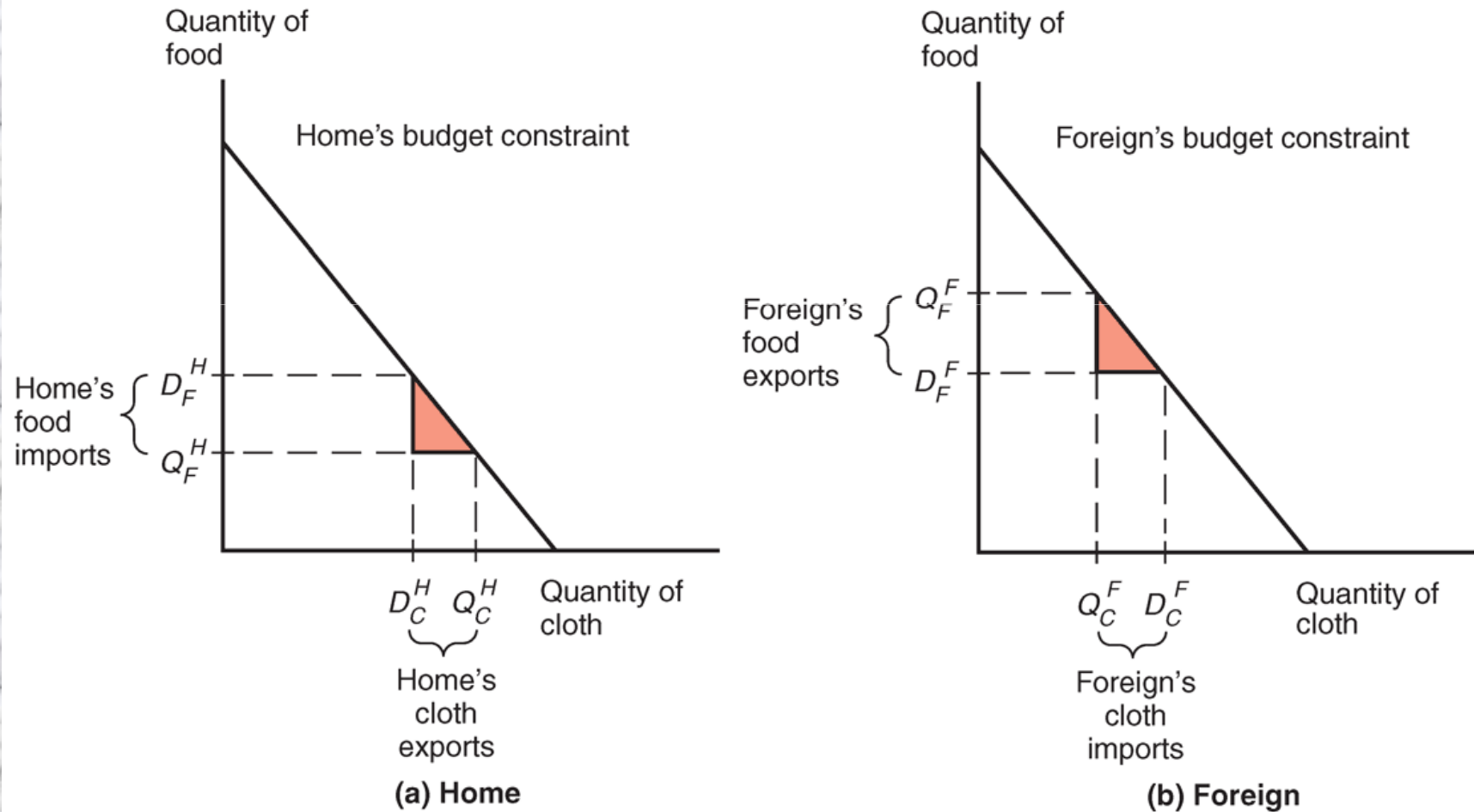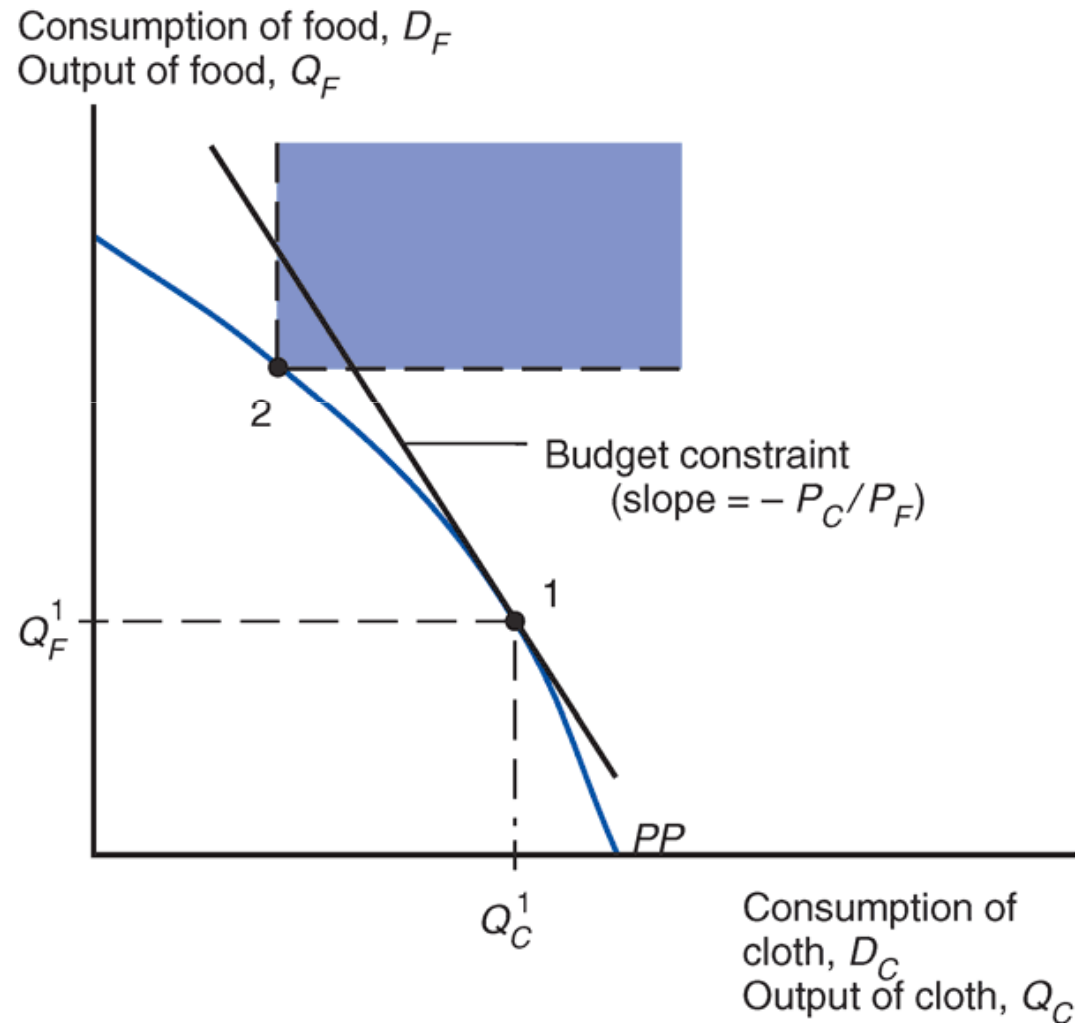(b) Foreign

Fig. 4-14: Trade Expands the Economy's Consumption Possibilities

Consumption of food, D_F
Output of food, Q_F

Budget constraint
(slope $= - P_C/P_F$)

2

1

Q_F^1

PP

Q_C^1

Consumption of
cloth, D_C
Output of cloth, Q_C

Trade in the Heckscher-Ohlin Model (cont.)

- Because an economy can afford to consume more with trade, the country *as a whole* is made better off.

- But *some* do not gain from trade, unless the model accounts for a redistribution of income.

- Trade changes relative prices of goods, which have effects on the relative earnings of workers and land owners.

  - A rise in the price of cloth raises the purchasing power of domestic workers, but lowers the purchasing power of domestic land owners.

- The model predicts that owners of abundant factors gain with trade, but owners of scarce factors lose.

Factor Price Equalization

- Unlike the Ricardian model, the Heckscher-Ohlin model predicts that input (factor) prices will be equalized among countries that trade.

- Because relative output prices are equalized and because of the direct relationship between output prices and factor prices, factor prices are also equalized.

- Trade increases the demand of goods produced by abundant factors, indirectly increasing the demand of the abundant factors themselves, raising the prices of the abundant factors across countries.

Factor Price Equalization (cont.)

- But factor prices are not really equal across countries.

- The model assumes that trading countries produce the same goods, so that prices for those goods will equalize, but countries may produce different goods.

- The model also assumes that trading countries have the same technology, but different technologies could affect the productivities of factors and therefore the wages/rates paid to these factors.

Factor Price Equalization (cont.)

- The model also ignores trade barriers and transportation costs, which may prevent output prices and factor prices from equalizing.

- The model predicts outcomes for the long run, but 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.

Does Trade Increase Income Inequality?

- Over the last 40 years, countries like South Korea, Mexico, and China have exported to the U.S. goods intensive in unskilled labor (ex., clothing, shoes, toys, assembled goods).

- At the same time, income inequality has increased in the U.S., as wages of unskilled workers have grown slowly compared to those of skilled workers.

- Did the former trend cause the latter trend?

Does Trade Increase Income Inequality? (cont.)

- The Heckscher-Ohlin model predicts that owners of abundant factors will gain from trade and owners of scarce factors will lose from trade.

- But little evidence supporting this prediction exists.

1. According to the model, a change in the distribution of income occurs through changes in output prices, but there is no evidence of a change in the prices of skill-intensive goods relative to prices of unskilled-intensive goods.

Does Trade Increase Income Inequality? (cont.)

2. According to the model, wages of unskilled workers should increase in unskilled labor abundant countries relative to wages of skilled labor, but in some cases the reverse has occurred:

   ♦ Wages of skilled labor have increased more rapidly in Mexico than wages of unskilled labor.

     • But compared to the U.S. and Canada, Mexico is supposed to be abundant in unskilled workers.

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

Trade and Income Distribution

- Changes in income distribution occur with every economic change, not only international trade.
  - ◆ Changes in technology, changes in consumer preferences, exhaustion of resources and discovery of new ones all affect income distribution.
  - ◆ Economists put most of the blame on technological change and the resulting premium paid on education as the major cause of increasing income inequality in the US.

- It would be better to compensate the losers from trade (or any economic change) than prohibit trade.
  - ◆ The economy as a whole does benefit from trade.

Trade and Income Distribution (cont.)

- There is a political bias in trade politics: potential losers from trade are better politically organized than the winners from trade.

  - ◆ Losses are usually concentrated among a few, but gains are usually dispersed among many.

  - ◆ Each of you pays about $8/year to restrict imports of sugar, and the total cost of this policy is about $2 billion/year.

  - ◆ The benefits of this program total about $1 billion, but this amount goes to relatively few sugar producers.

Empirical Evidence of the Heckscher-Ohlin Model

- ## Tests on US data

  - ◆ Leontief found that U.S. exports were less capital-intensive than U.S. imports, even though the U.S. is the most capital-abundant country in the world: **Leontief paradox**.

- ## Tests on global data

  - ◆ Bowen, Leamer, and Sveikauskas tested the Heckscher-Ohlin model on data from 27 countries and confirmed the Leontief paradox on an international level.

- ## Tests on manufacturing data between low/middle income countries and high income countries.

  - ◆ This data lends more support to the theory.

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.

Table 4-3: Testing the Heckscher-Ohlin Model

Factor of Production	Predictive Success[*]
Capital	0.52
Labor	0.67
Professional workers	0.78
Managerial workers	0.22
Clerical workers	0.59
Sales workers	0.67
Service workers	0.67
Agricultural workers	0.63
Production workers	0.70
Arable land	0.70
Pasture land	0.52
Forest	0.70

[*] Fraction of countries for which net exports of factor runs in predicted direction.

Source: Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *American Economic Review* 77 (December 1987), pp. 791–809.

Table 4-4: Estimated Technological Efficiency, 1983 (United States = 1)

Country	
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Daniel Trefler, *American Economic Review* (December 1995), p. 1037.

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

- Because the Heckscher-Ohlin model predicts that factor prices will be equalized across trading countries, it also predicts that factors of production will produce and export a certain quantity goods until factor prices are equalized.

  - In other words, a predicted value of services from factors of production will be *embodied* in a predicted volume of trade between countries.

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

- But because factor prices are not equalized across countries, the predicted volume of trade is much larger than actually occurs.

  ◆ A result of "missing trade" discovered by Daniel Trefler.

- The reason for this "missing trade" appears to be the assumption of identical technology among countries.

  ◆ Technology affects the productivity of workers and therefore the value of labor services.

  ◆ A country with high technology and a high value of labor services would not necessarily import a lot from a country with low technology and a low value of labor services.

Summary

1. Substitution of factors used in the production process is represented by a curved PPF.

    ♦ When an economy produces a low quantity of a good, the opportunity cost of producing that good is low and the marginal productivity of resources used to produce that good is high.

    ♦ When an economy produces a high quantity of a good, the opportunity cost of producing that good is high and the marginal productivity of resources used to produce that good is low.

2. When an economy produces the most it can from its resources, the opportunity cost of producing a good equals the relative price of that good in markets.

Summary (cont.)

3. If the relative price of a good increases, then the real wage or real lending/renting rate of the factor used intensively in the production of that good is predicted to increase,

    ◆ while the real wage and real lending/renting rates of other factors of production are predicted to decrease.

4. If output prices remain constant as the amount of a factor of production increases, then the supply of the good that uses this factor intensively is predicted to increase, and the supply of other goods is predicted to decrease.

Summary (cont.)

5. An economy is predicted to 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 is predicted to be better off with trade, even though owners of scarce factors are predicted to 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.

Additional Chapter Art
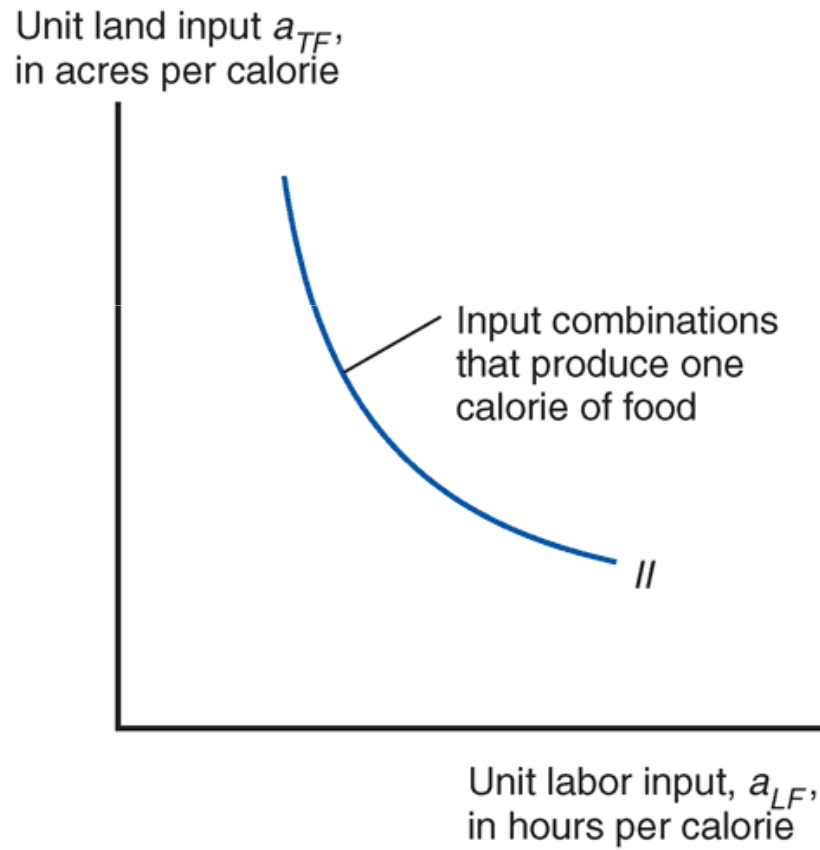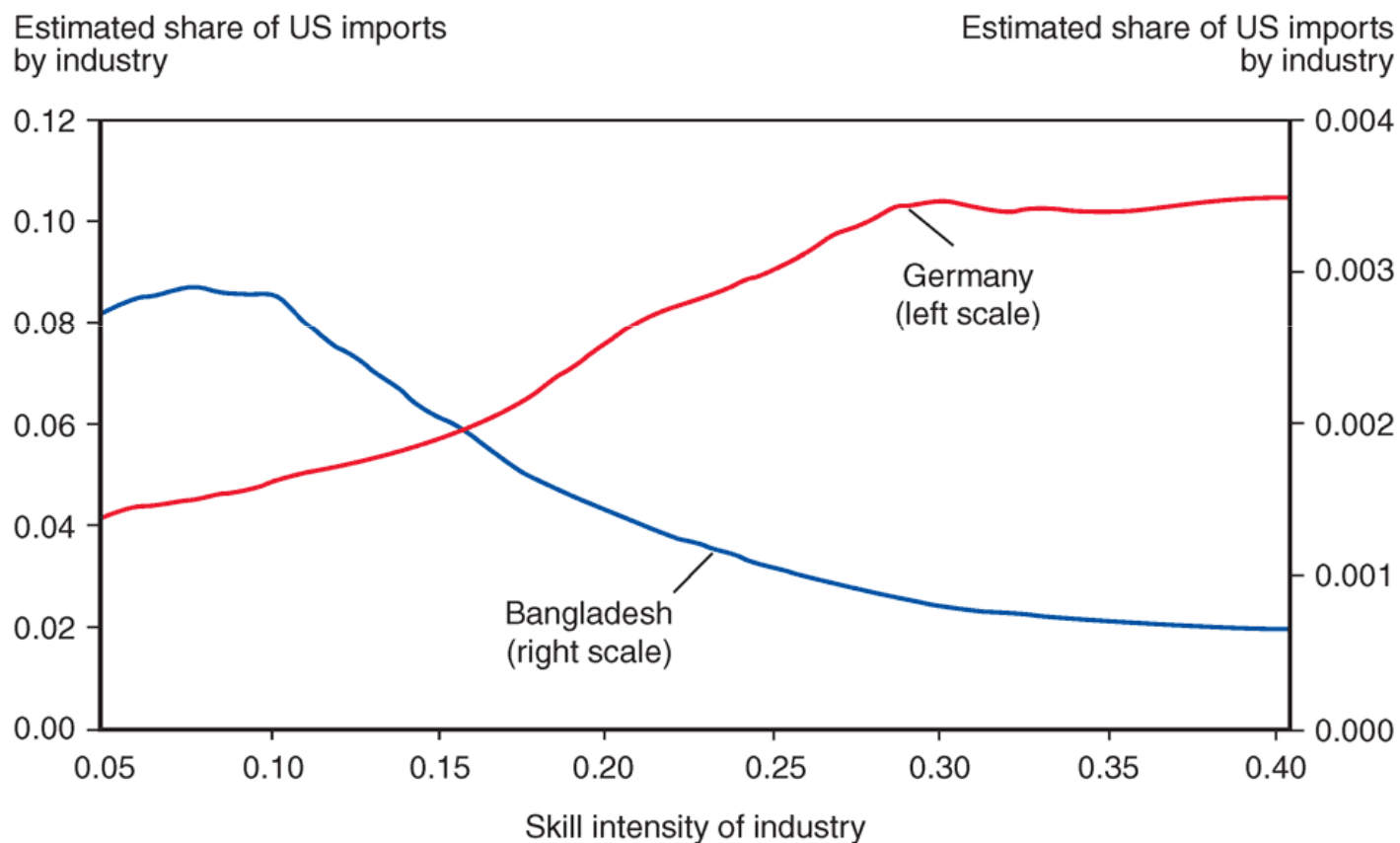
Fig. 4-4: Input Possibilities in Food Production

Unit land input a_{TF}, in acres per calorie

Input combinations that produce one calorie of food

II

Unit labor input, a_{LF}, in hours per calorie

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

Country	Hourly Compensation of Production Workers, 2005
United States	100
Germany	140
Japan	92
Spain	75
South Korea	57
Portugal	31
Mexico	11
China*	3

* 2004

Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page.*

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

Estimated share of US imports by industry

Estimated share of US imports by industry

Germany (left scale)

Bangladesh (right scale)

Skill intensity of industry

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

4-63

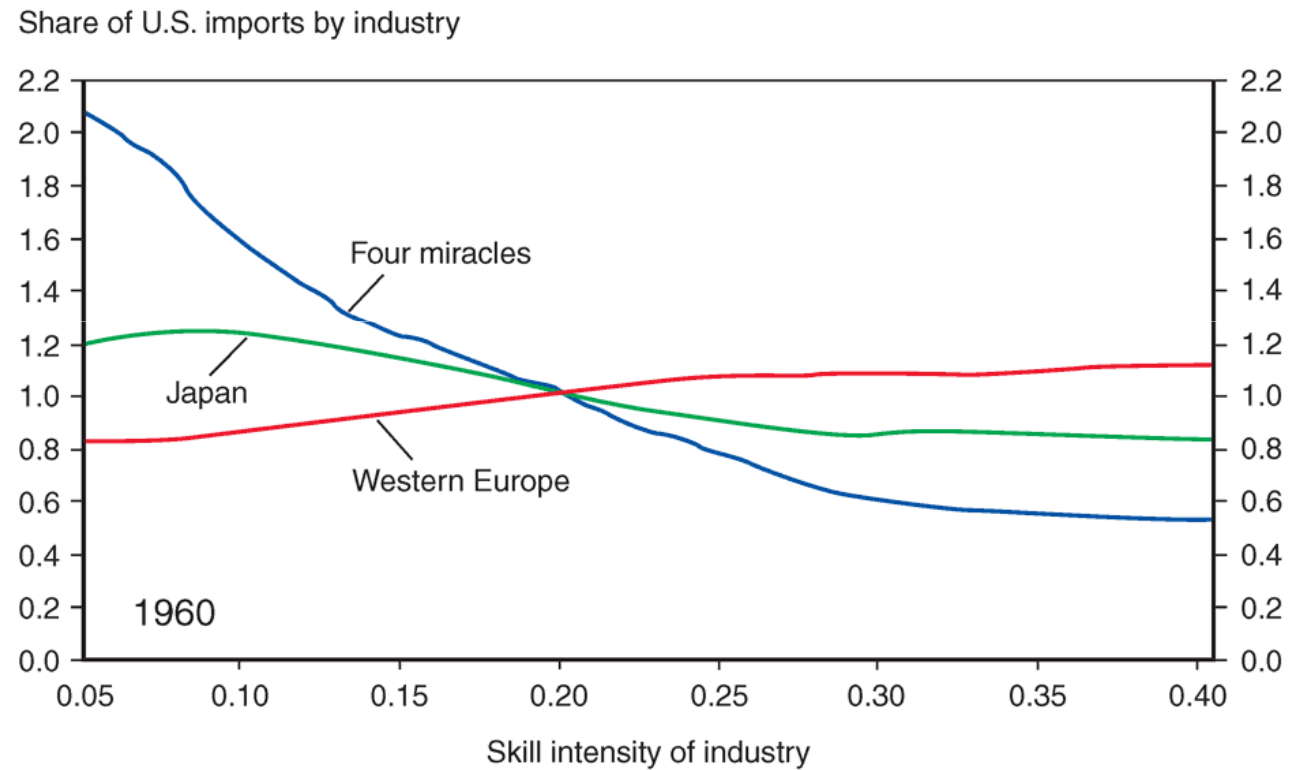# Fig. 4-16 Changing Patterns of Comparative Advantage

Share of U.S. imports by industry

Four miracles

Japan

Western Europe

1960

Skill intensity of industry

(a) 1960

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

Share of U.S. imports by industry

(a) 1998
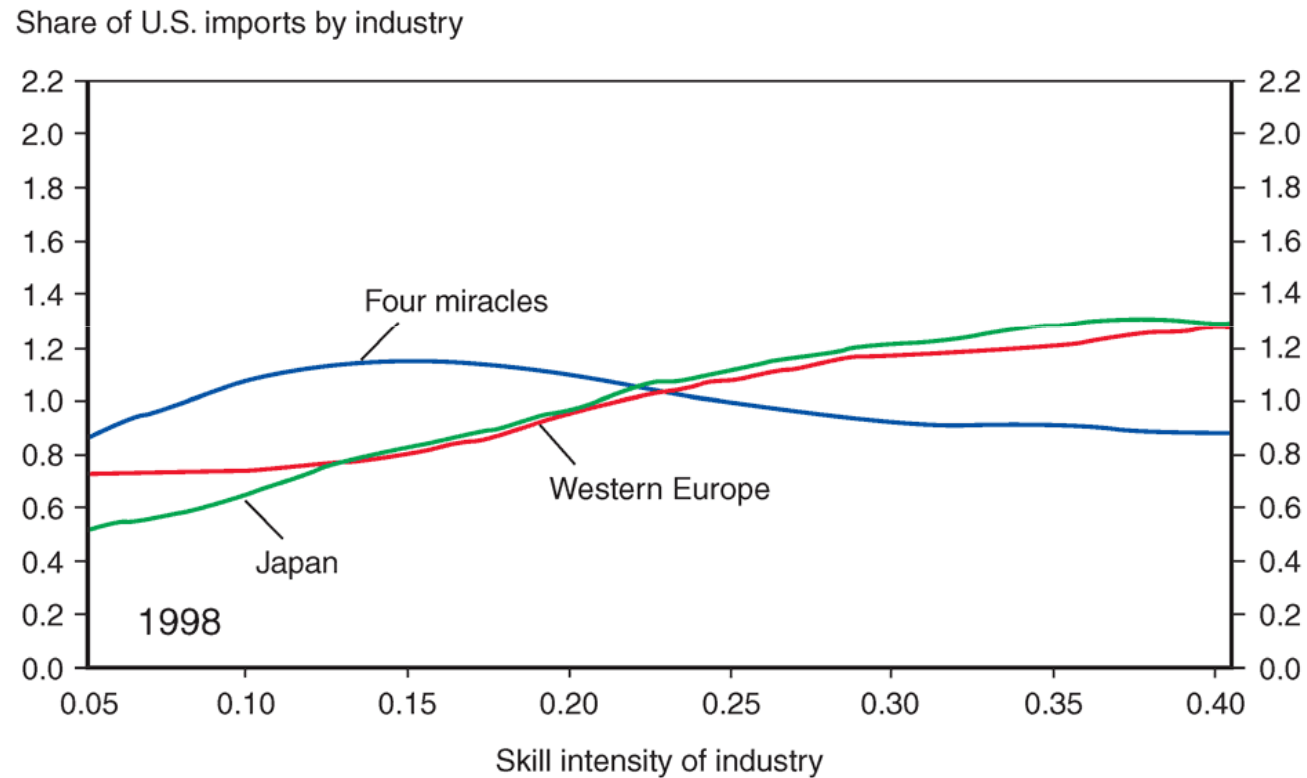
Table 4-5: Estimated Technological Efficiency, 1983 (United States = 1)

Country	
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Daniel Trefler, *American Economic Review* (December 1995), p. 1037.
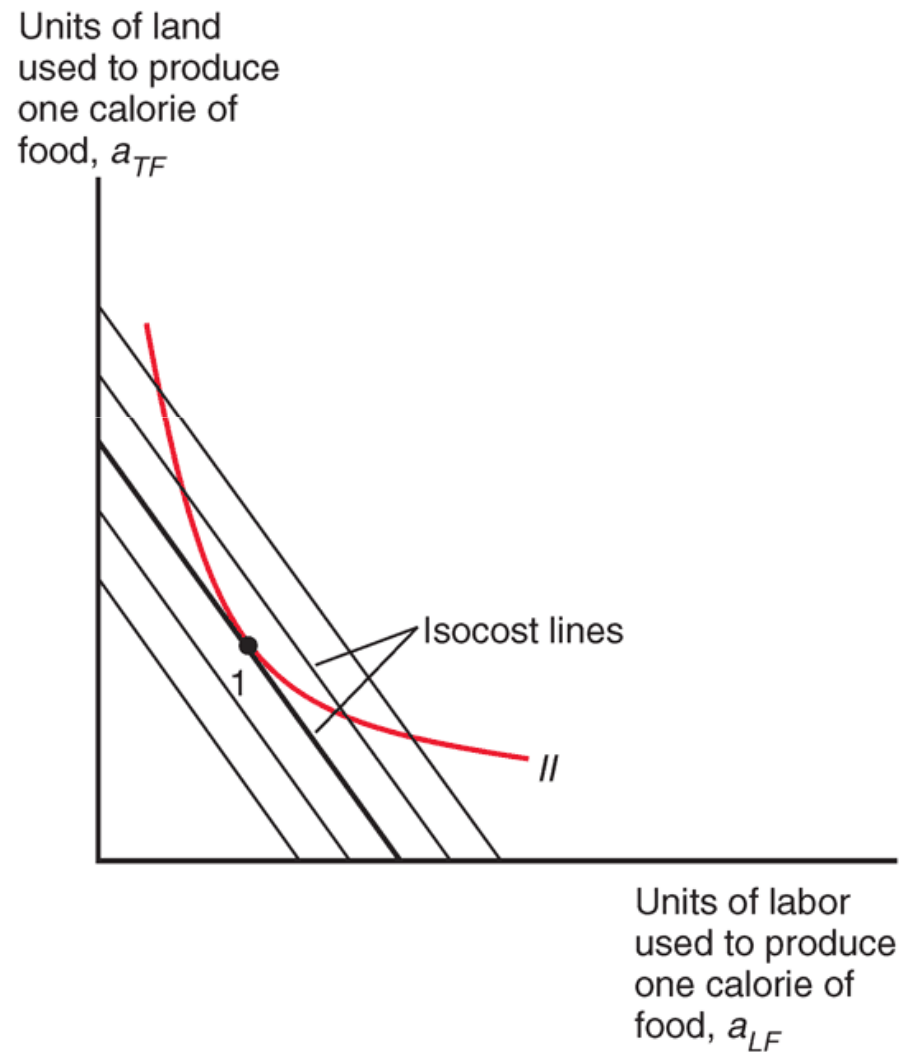
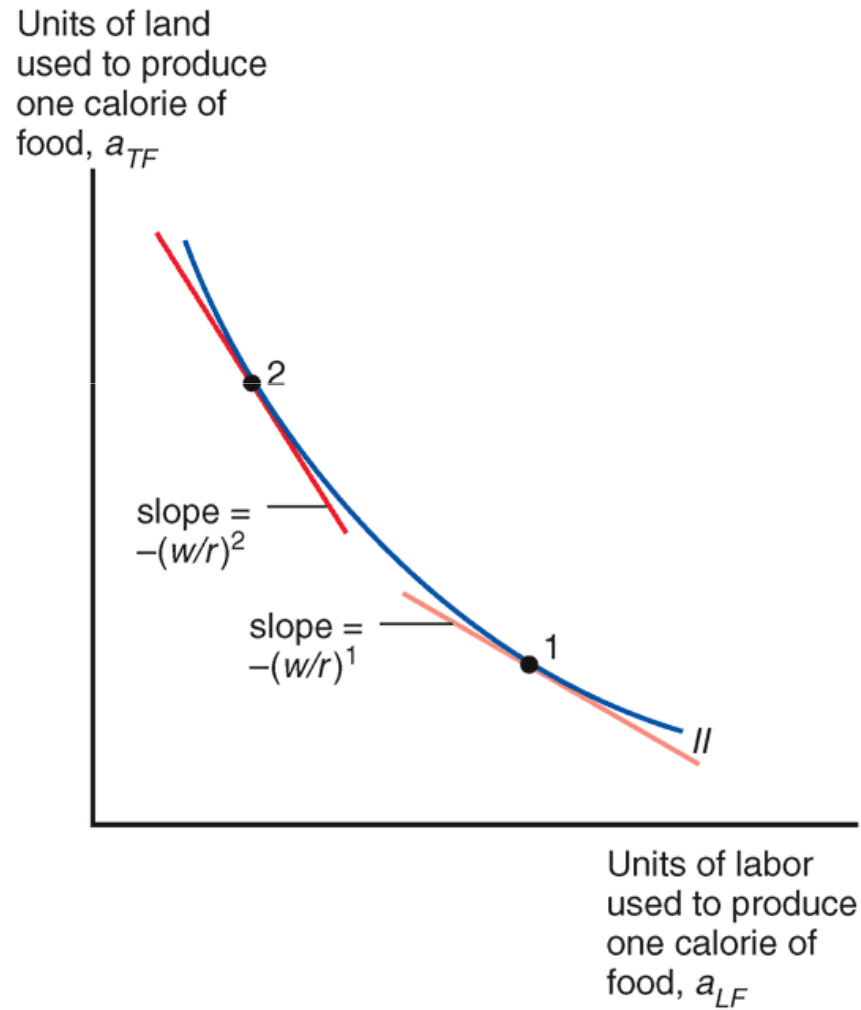# Fig. 4A-1: Choosing the Optimal Land-Labor Ratio

Units of land used to produce one calorie of food, a_{TF}

Isocost lines

1

II

Units of labor used to produce one calorie of food, a_{LF}

Fig. 4A-2: Changing the Wage-Rental Ratio

Units of land used to produce one calorie of food, a_{TF}

slope $= -(w/r)^2$

slope $= -(w/r)^1$

II

Units of labor used to produce one calorie of food, a_{LF}

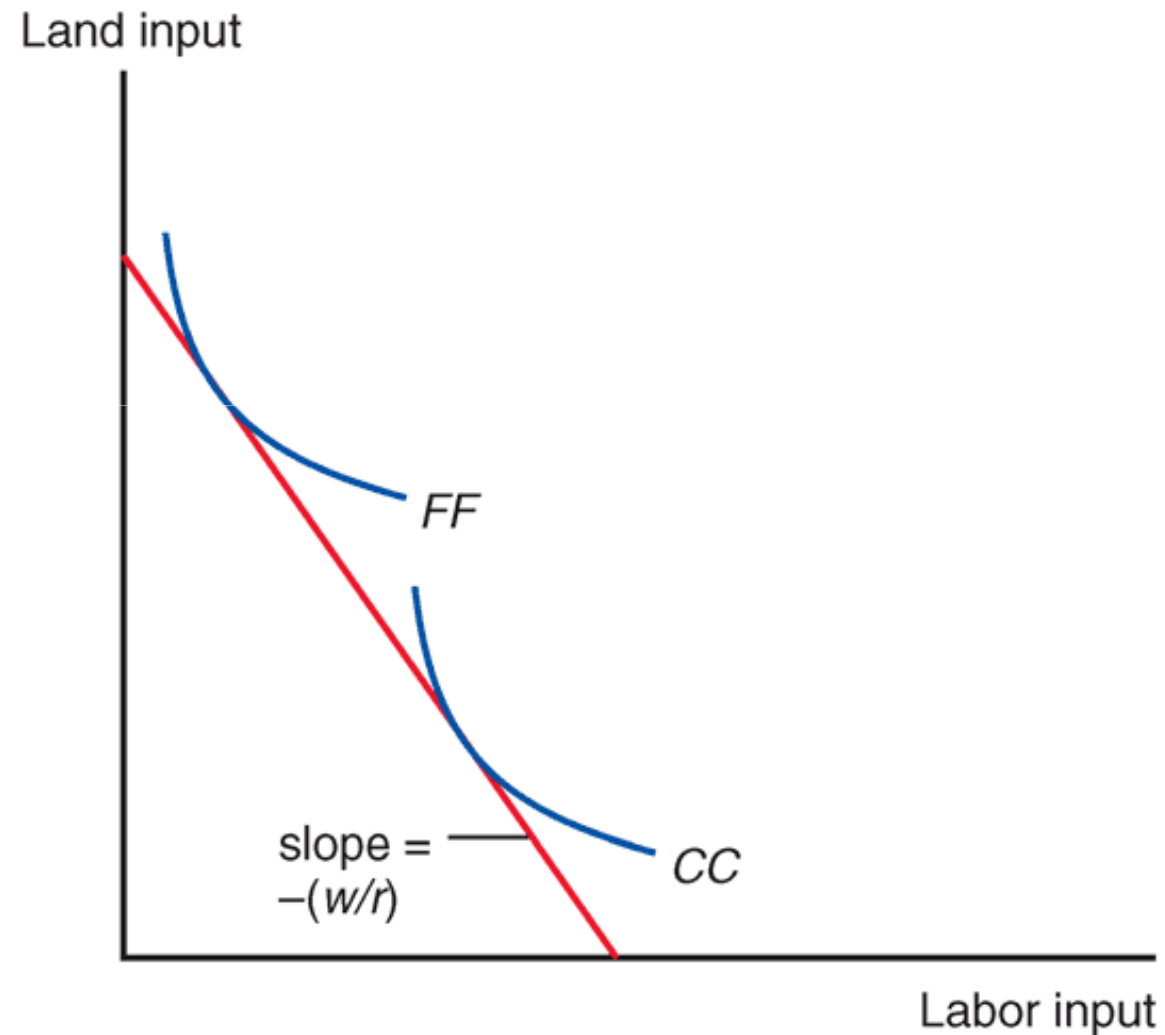# Fig. 4A-3: Determining the Wage-Rental Ratio

Land input

slope = ─── −(w/r)

FF

CC

Labor input

Fig. 4A-4: A Rise in the Price of Cloth

Land input

slope =
$-(w/r)^1$

FF

slope =
$-(w/r)^2$

CC^1

CC^2

Labor input