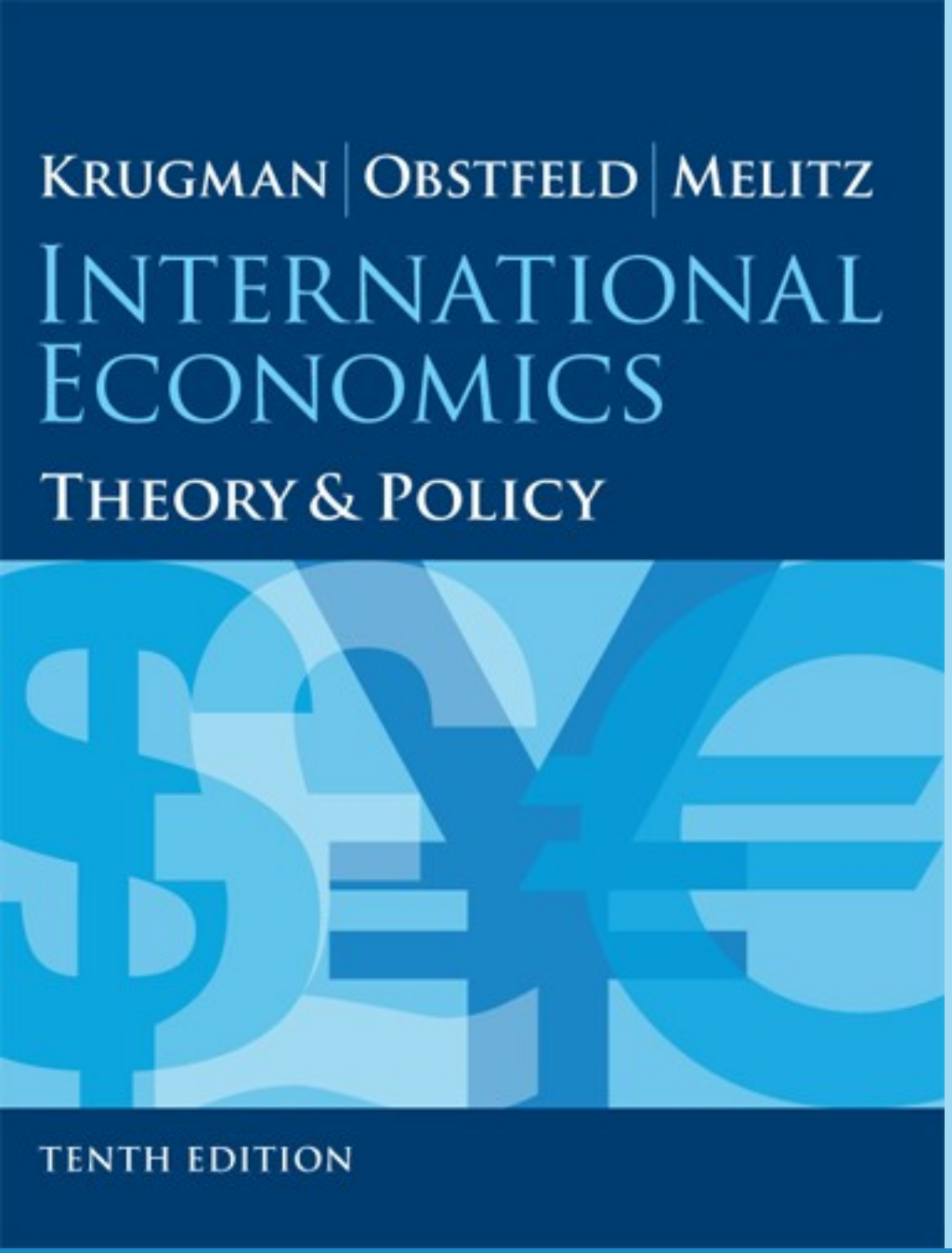


Chapter 5

Resources and Trade: The Heckscher-Ohlin Model

Preview

- Assumptions of the Heckscher-Ohlin model
- Production possibilities
- Choosing the mix of inputs
- Relations among factor prices, goods prices, resources and output
- Trade in the Heckscher-Ohlin model
- Trade and income distribution
- Empirical evidence

Introduction

- In addition to differences in labor productivity, trade occurs due to differences in resources across countries.
- The Heckscher-Ohlin theory argues that trade occurs due to differences in labor, labor skills, physical capital, capital, or other factors of production across countries.
  - Countries have different *relative abundance* of factors of production.
  - Production processes use factors of production with different *relative intensity*.

Two-Factor Heckscher-Ohlin Model

1. Two countries: home and foreign, both have the same technology
2. Two goods: cloth (C) and food (F).
3. Two factors of production: labor (L) and capital (K).
4. The mix of labor and capital used varies across goods.
   - cloth is labor-intensive and food is capital-intensive
5. The supply of labor and capital in each country is constant and varies across countries.
6. In the long run, both labor and capital can move across sectors, equalizing their returns (wage and rental rate) across sectors.

Production Possibilities

- With more than one factor of production, the opportunity cost is no longer constant and the PPF is no longer a straight line. **Why?**
- Numerical example:

  K = 3000, total amount of capital

  L = 2000, total amount of labor

- Suppose a fixed mix of capital and labor in each sector.

  a_{KC} = 2, capital used to produce one yard of cloth

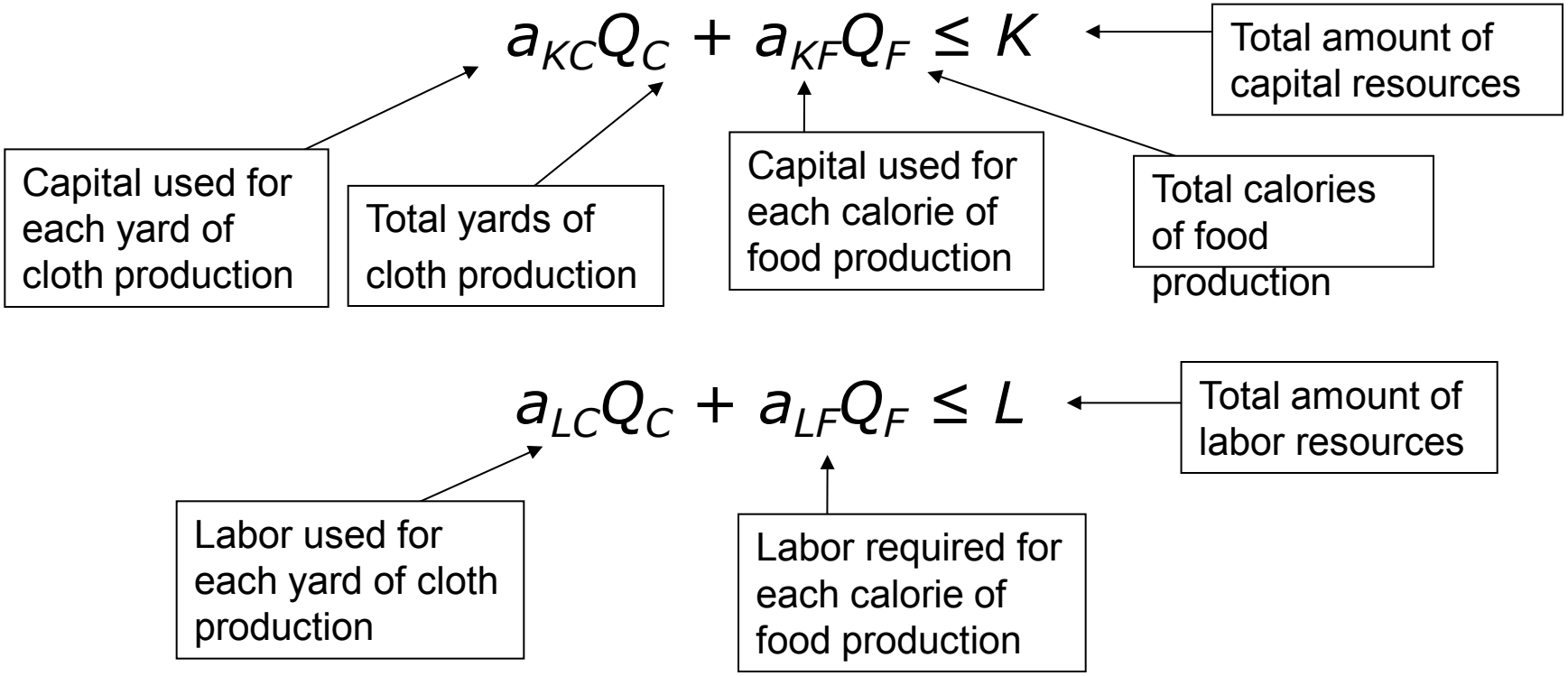
  a_{LC} = 2, labor used to produce one yard of cloth

  a_{KF} = 3, capital used to produce one calorie of food

  a_{LF} = 1, labor used to produce one calorie of food

Production Possibilities

- Production possibilities are influenced by *both* capital and labor:



Production Possibilities

- Constraint on capital:

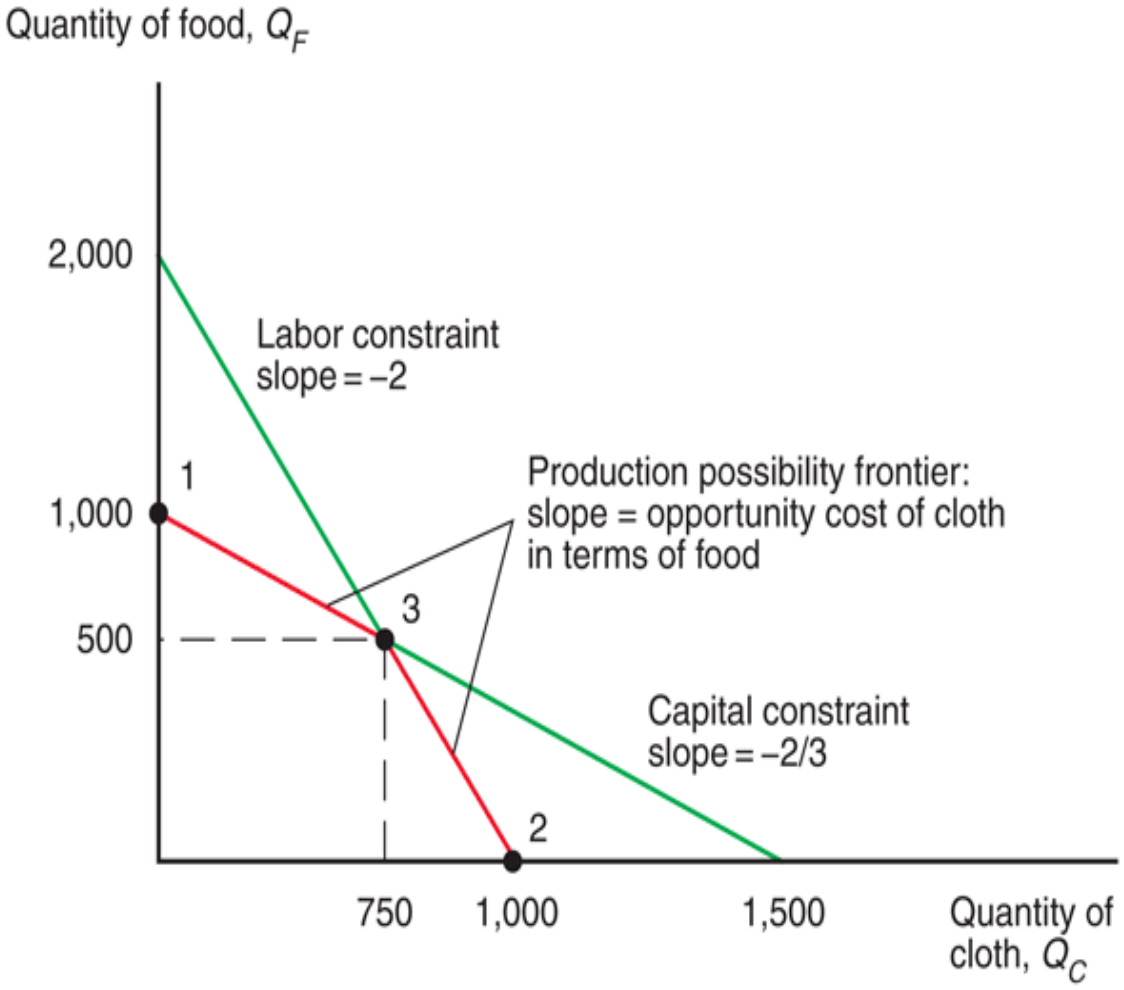
$$2Q_C + 3Q_F \leq 3000$$

- Constraint on labor:

$$2Q_C + Q_F \leq 2000$$

- Economy must produce subject to both constraints – i.e., it must have enough capital and labor.
- Without factor substitution, the production possibilities frontier is the interior of the two factor constraints.

Fig. 5-1: The Production Possibility Frontier without Factor Substitution



Max food production 1000 (point 1) fully uses capital, with excess labor.

Max cloth 1000 (point 2) fully uses labor, with excess capital.

Intersection of labor and capital constraints occurs at 500 calories of food and 750 yards of cloth (point 3).

Fig. 5-2: The Production Possibility Frontier with Factor Substitution

The PPF equations from previous slides do not allow substitution of capital for labor in production.

If producers can substitute one input for another in the production process, then the PPF is curved (bowed).

Opportunity cost of cloth increases as producers make more cloth.

When the economy devotes more resources towards production of one good, the marginal productivity of those resources tends to be low so that the opportunity cost is high.

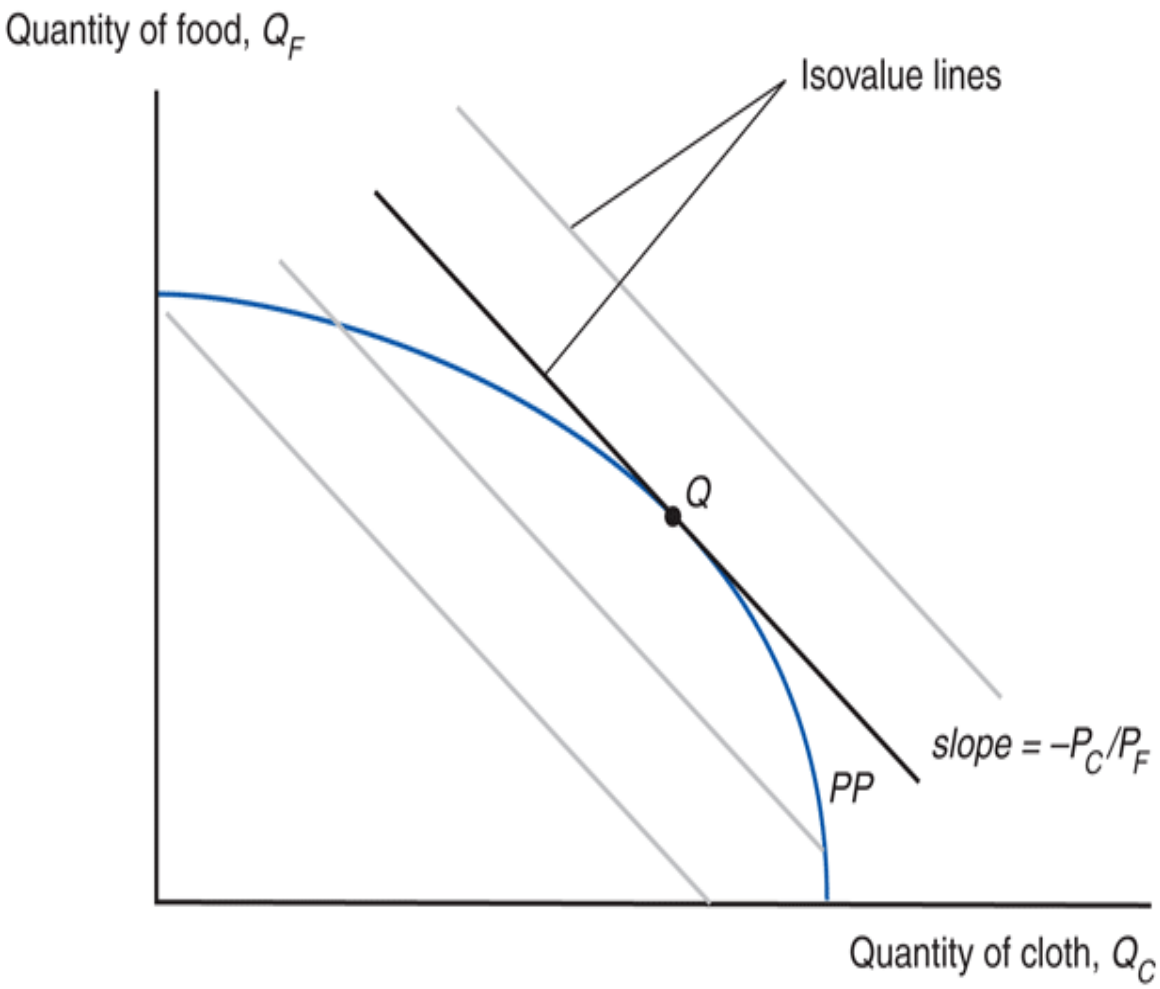
Production Possibilities

- What does the country produce?
- The economy produces at the point that maximizes the value of production, *V.*
- An **isovalue** line is a line representing a constant value of production, *V:*

$$V = P_C Q_C + P_F Q_F$$

  - where P_C and P_F are the prices of cloth and food.
  - slope of isovalue line is $-(P_C/P_F)$

Fig. 5-3: Prices and Production

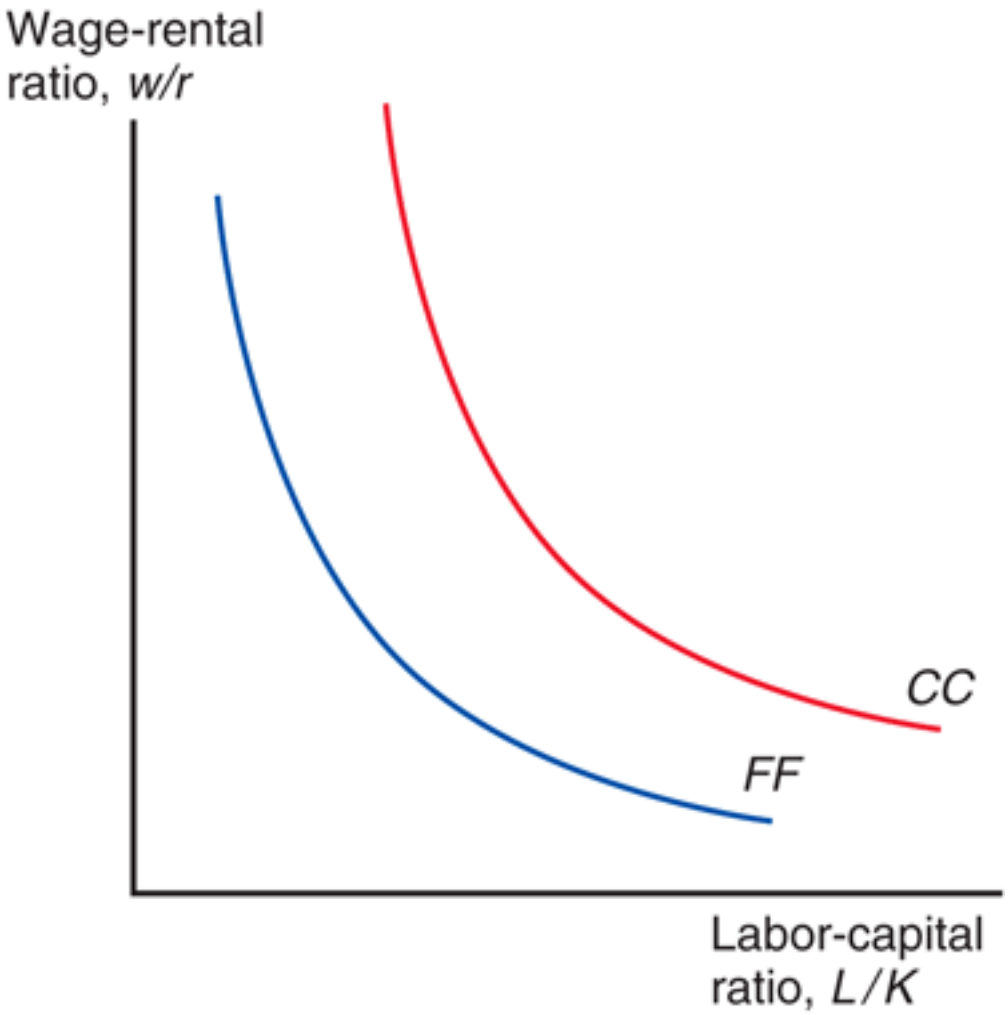


Given the relative price of cloth, the economy produces at the point *Q* that touches the highest possible isovalue line.

At that point, the relative price of cloth equals the slope of the PPF, which equals *the opportunity cost of producing cloth.*

The trade-off in production equals the trade-off according to market prices.

Fig. 5-5: Factor Prices and Input Choices

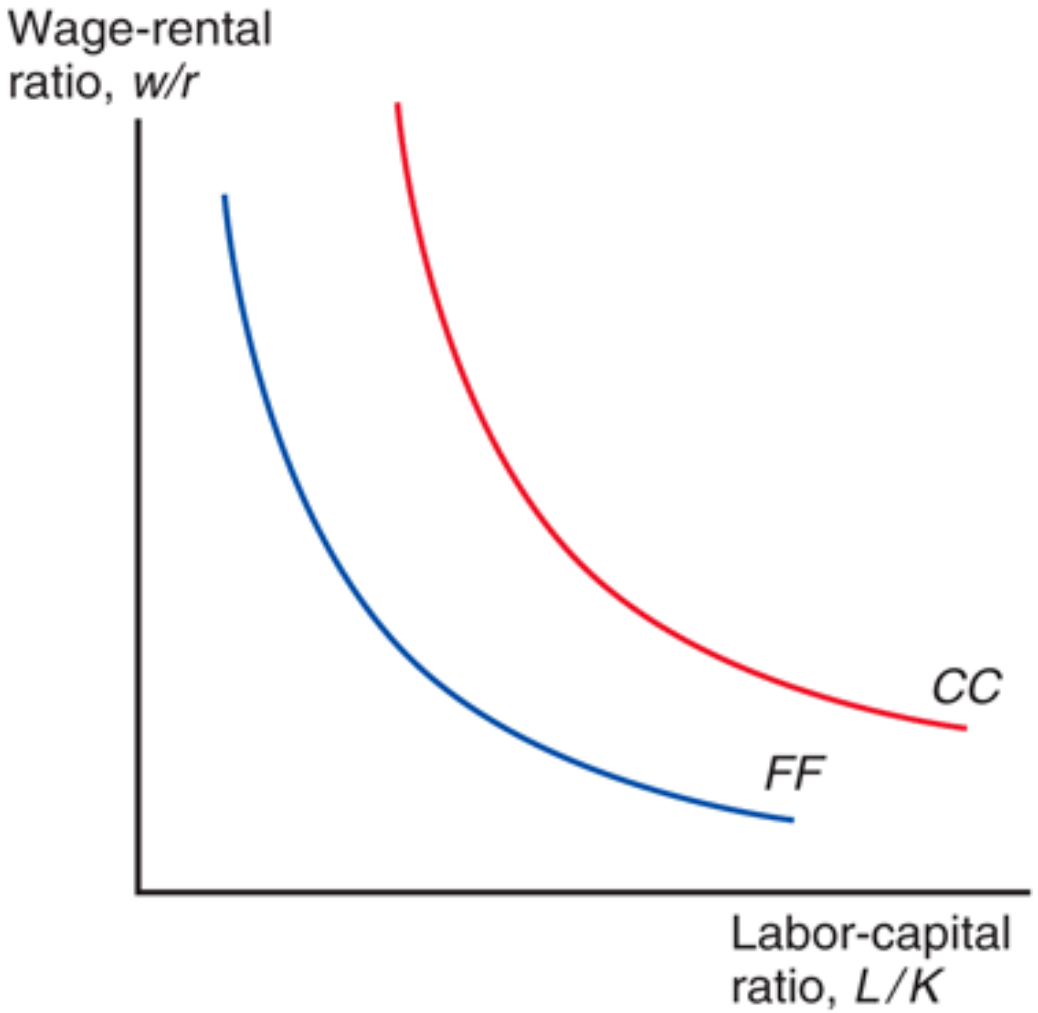


Producers may choose different amounts of factors of production used to make cloth or food.

Their choice depends on the wage, *w*, paid to labor and the rental rate, *r*, paid when renting capital.

As the wage *w* increases relative to the rental rate *r,* producers use less labor and more capital in the production of both food and cloth.

Fig. 5-5: Factor Prices and Input Choices



Assume that at any given factor prices, cloth production uses more labor relative to capital than food production uses:

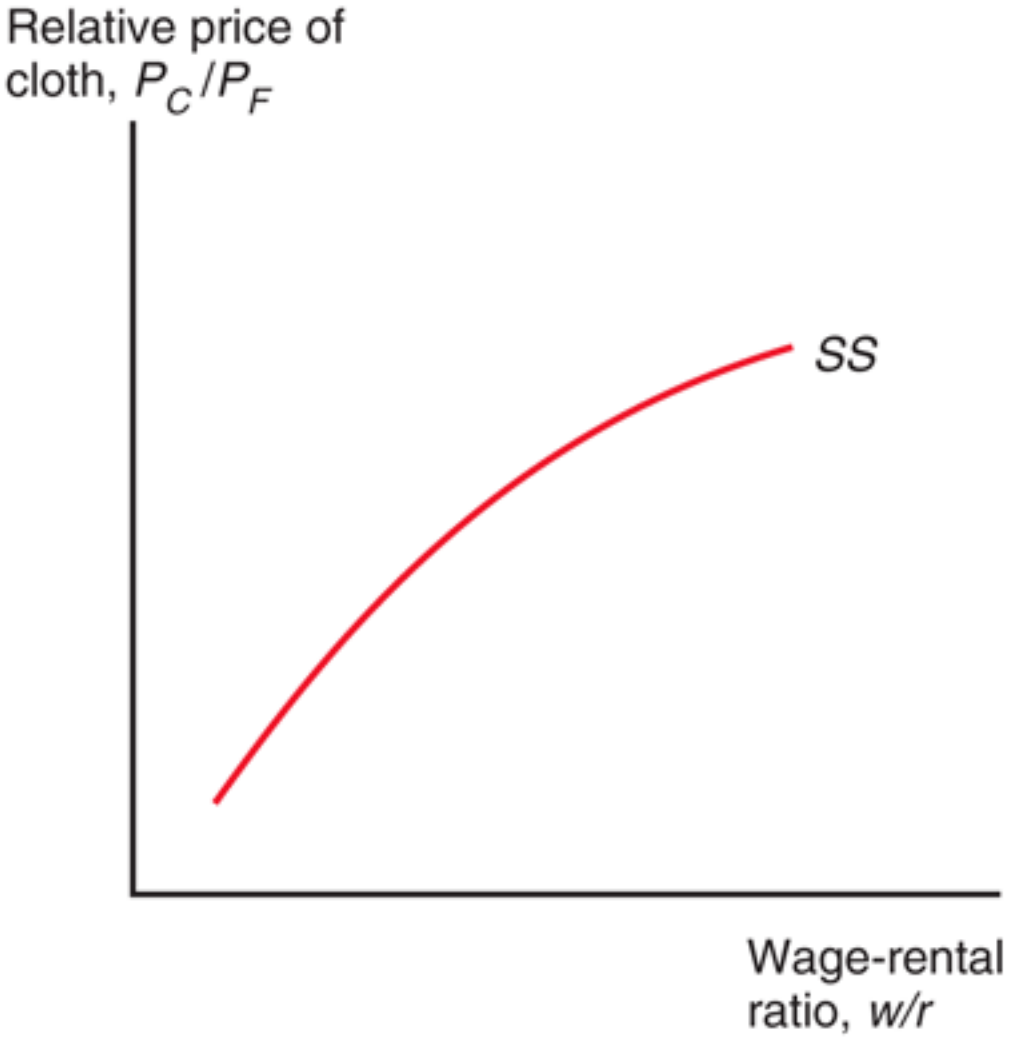
$$a_{LC}/a_{KC} > a_{LF}/a_{KF}$$

$$L_C/K_C > L_F/K_F$$

Production of cloth is relatively **labor intensive**, while production of food is relatively **capital intensive**.

Relative factor demand curve for cloth *CC* lies outside that for food *FF.*

Fig. 5-6: Factor Prices and Goods Prices



In competitive markets, the price of a good should equal its cost of production, which depends on the factor prices.

How changes in the wage and rent affect the cost of producing a good depends on the mix of factors used.

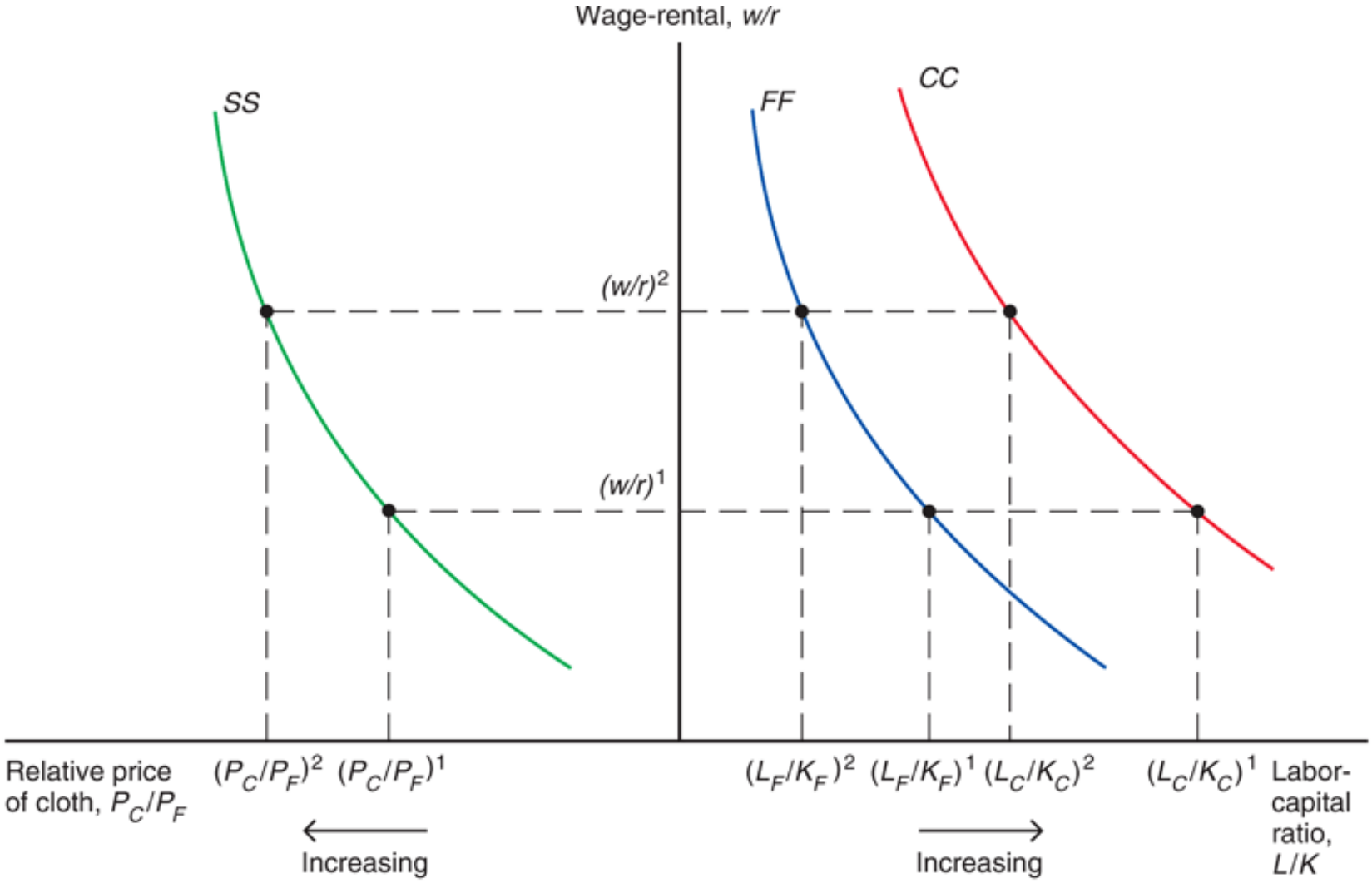
An increase in the rental rate of capital should affect the price of food more than the price of cloth since food is the capital intensive industry.

Changes in w/r are positively tied to changes in P_C/P_W.

Factor Prices and Goods Prices

- **Stolper-Samuelson theorem**: If the relative price of a good increases, then the real wage or rental rate of the factor used intensively in the production of that good increases, while the real wage or rental rate of the other factor decreases.
- Any change in the relative price of goods alters the distribution of income.

Fig. 5-7: From Goods Prices to Input Choices



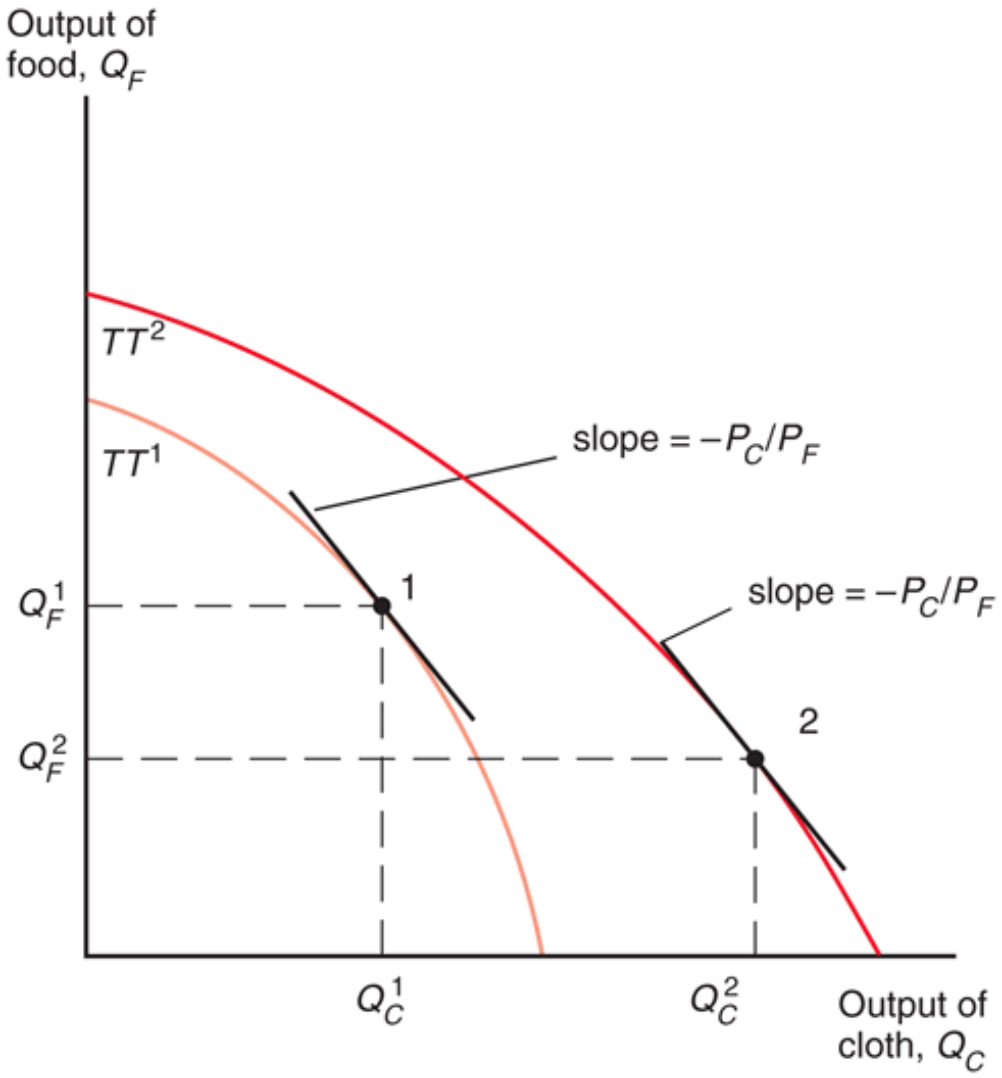
Factor Prices and Goods Prices

- An increase in the relative price of cloth, P_C/P_F, is predicted to
  - raise income of workers relative to that of capital owners, *w/r*.
  - raise the ratio of capital to labor services, *K/L*, used in both industries.
    - the marginal product of labor increases and the marginal product of capital decreases
  - raise the real income (purchasing power) of workers and *lower the real income of capital owners,* in terms of both goods.

Resources and Output

- How do levels of output change when the economy's resources change?
- **Rybczynski theorem**: If you 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*.

Fig. 5-8: Resources and Production Possibilities



Assume an economy's labor force grows, which implies that its ratio of labor to capital *L/K* increases.

Expansion of production possibilities is biased toward cloth.

At a given relative price of cloth, the ratio of labor to capital used in both sectors remains constant, see Fig. 5-7.

To employ the additional workers, the economy expands production of the relatively labor-intensive good cloth and contracts production of the relatively capital-intensive good food.

Resources and Output

- An economy with a *high ratio of labor to capital* produces a *high output of cloth relative to food*.
- Suppose that Home is ***relatively abundant*** in labor and Foreign in capital:

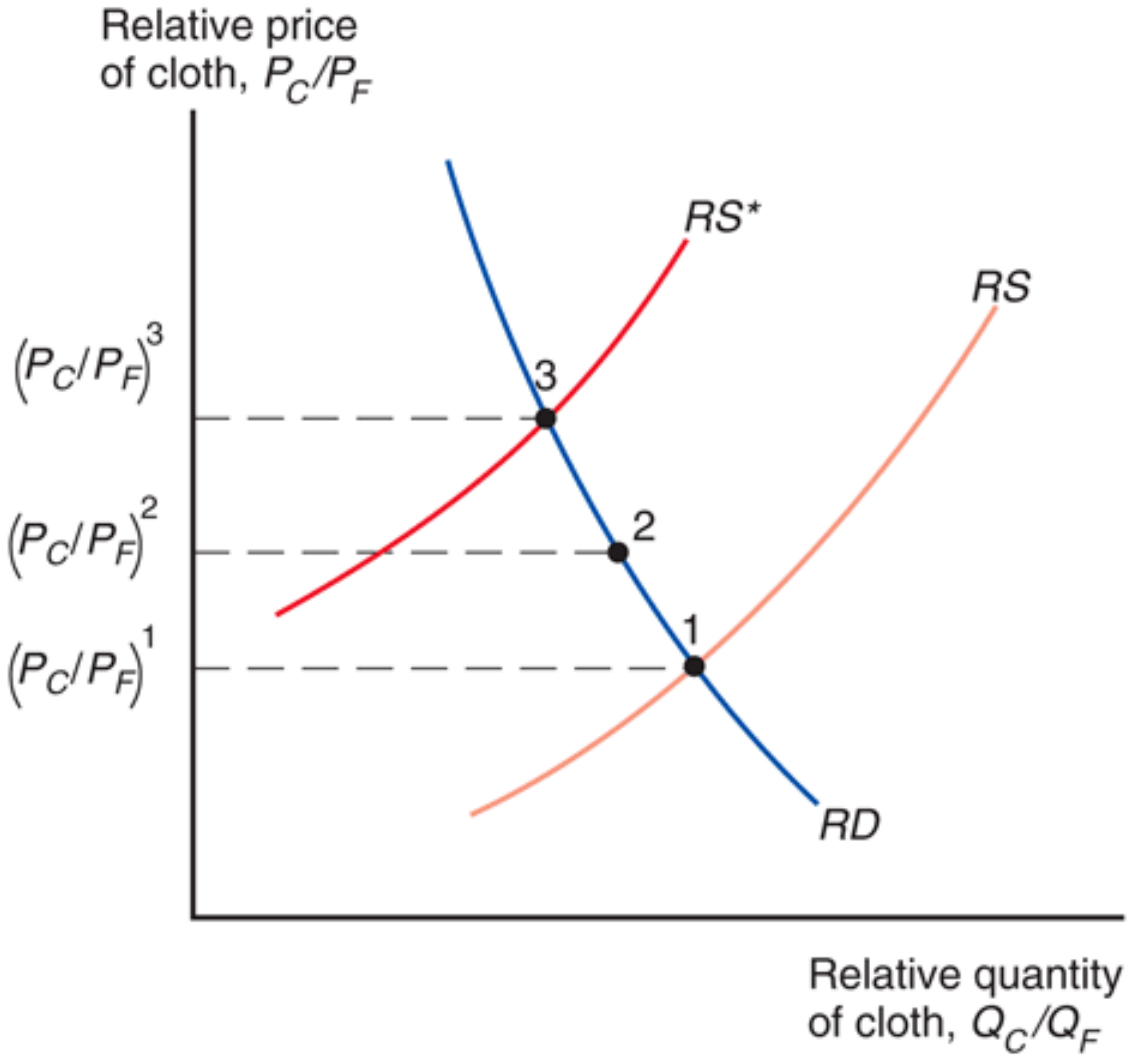
$$L/K > L^*/K^*$$

  - Likewise, Home is ***relatively scarce*** in capital and Foreign in labor.
- Home will be relatively efficient at producing cloth because cloth is *relatively labor intensive*.

Trade in the Heckscher-Ohlin Model

- The countries are assumed to have the same technology and the same tastes.
- With the same technology, each economy has a comparative advantage in producing the good that relatively intensively uses the factors of production in which the country is relatively well endowed.
- With the same tastes, the two countries will consume cloth to food in the same ratio when faced with the same relative price of cloth under free trade.

Fig. 5-9: Trade Leads to a Convergence of Relative Prices

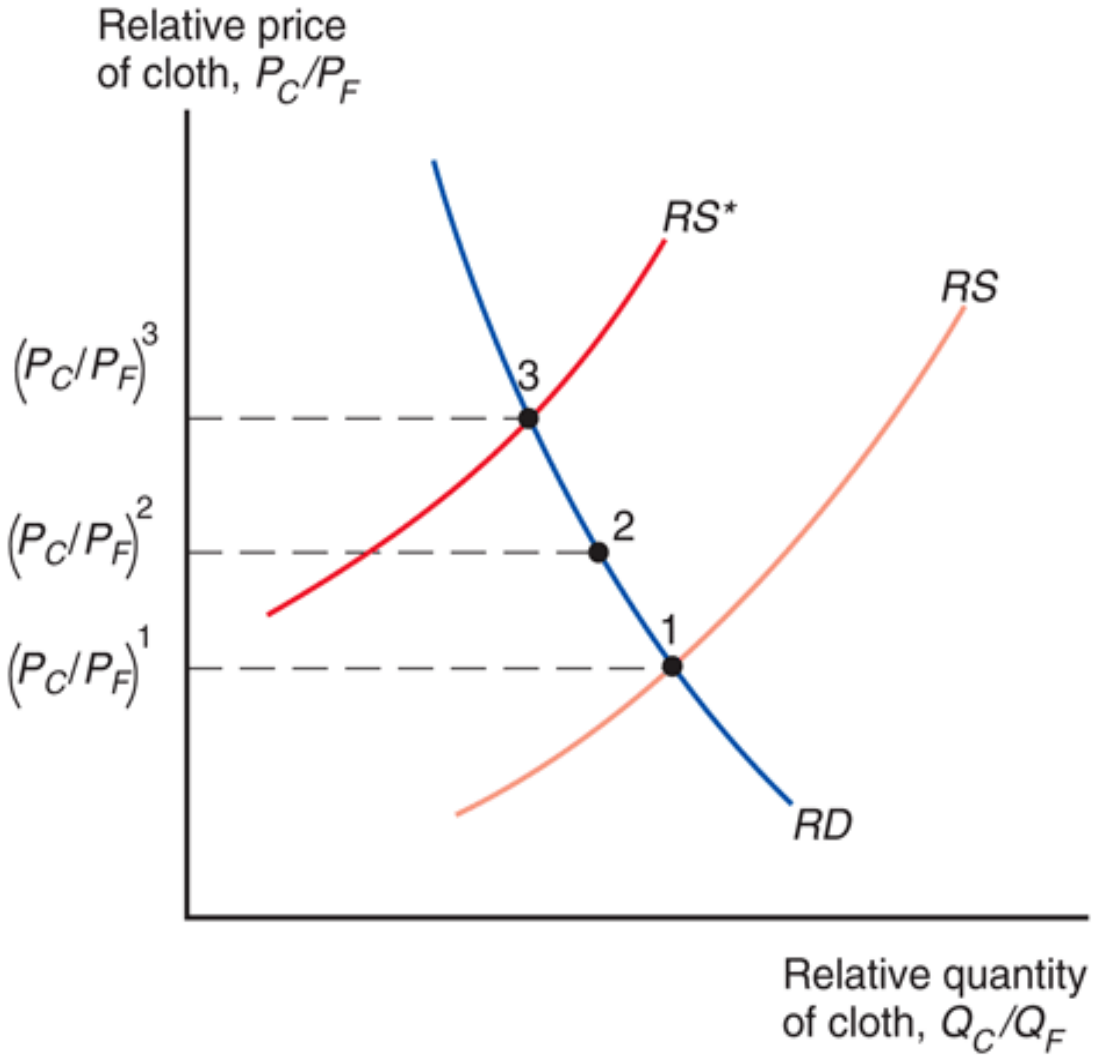


Since cloth is relatively labor intensive, at each relative price of cloth to food, Home will produce a higher ratio of cloth to food than Foreign.

Home will have a larger relative supply of cloth to food than Foreign.

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

Fig. 5-9: Trade Leads to a Convergence of Relative Prices



With trade, the relative price of cloth rises in the relatively labor abundant (home) country and falls in the relatively labor scarce (foreign) country.

In Home, 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.

Home becomes an exporter of cloth and an importer of food. Foreign becomes an importer of cloth and an exporter of food.

Trade in the Heckscher-Ohlin Model

- **Heckscher-Ohlin theorem**: *The country that is abundant in a factor exports the good whose production is intensive in that factor*.
- This result generalizes to a correlation:
  - *Countries tend to export goods whose production is intensive in factors with which the countries are abundantly endowed.*

Trade and the Distribution of Income

- Changes in relative prices can affect the earnings of labor and capital.
  - A rise in the price of cloth raises the purchasing power of labor in terms of both goods while lowering the purchasing power of capital in terms of both goods.
  - A rise in the price of food has the reverse effect.
- Thus, international trade can affect the distribution of income, even in the long run:
  - *Owners of a country's abundant factors gain from trade, but owners of a country's scarce factors lose.*
  - Factors of production that are used intensively by the import-competing industry are hurt by the opening of trade – regardless of the industry in which they are employed.

North-South Trade and Income Inequality

- Compared with the rest of the world, the United States is abundantly endowed with highly skilled labor while low-skilled labor is correspondingly scarce.
- 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?

North-South Trade and Income Inequality

- The Heckscher-Ohlin model predicts that
  - owners of relatively abundant factors will gain from trade (skilled labor in USA)
  - owners of relatively scarce factors will lose from trade (unskilled labor in USA)
- This explanation is however very problematic!!!

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.

North-South Trade and Income Inequality

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.

North-South Trade and Income Inequality

- The majority view of trade economists is that the villain is not trade but rather new production technologies that put a greater emphasis on worker skills (such as the widespread introduction of computers and other advanced technologies in the workplace).

Fig. 5-10: Increased Wage Inequality: Trade or Skill-Biased Technological Change?

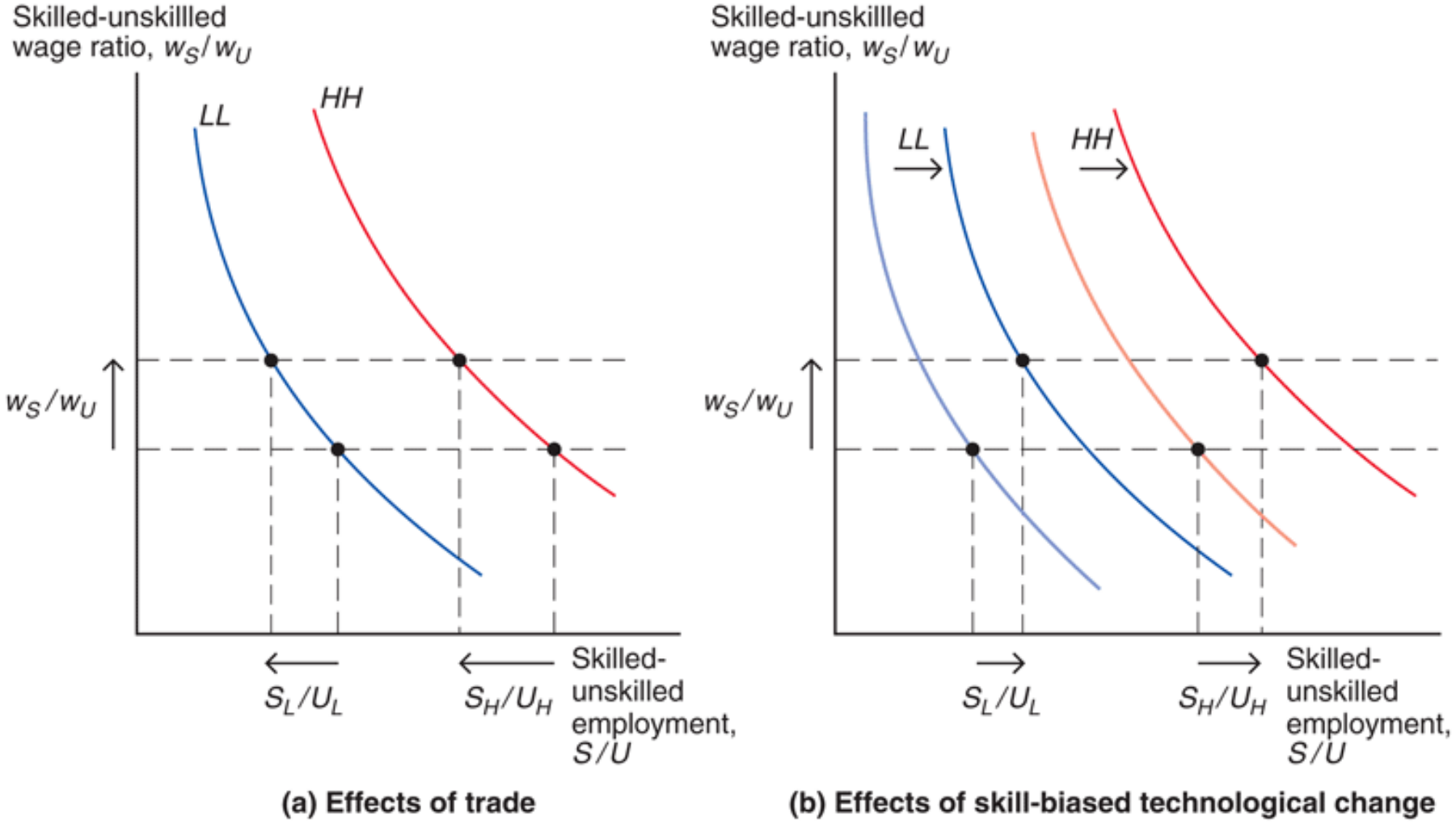
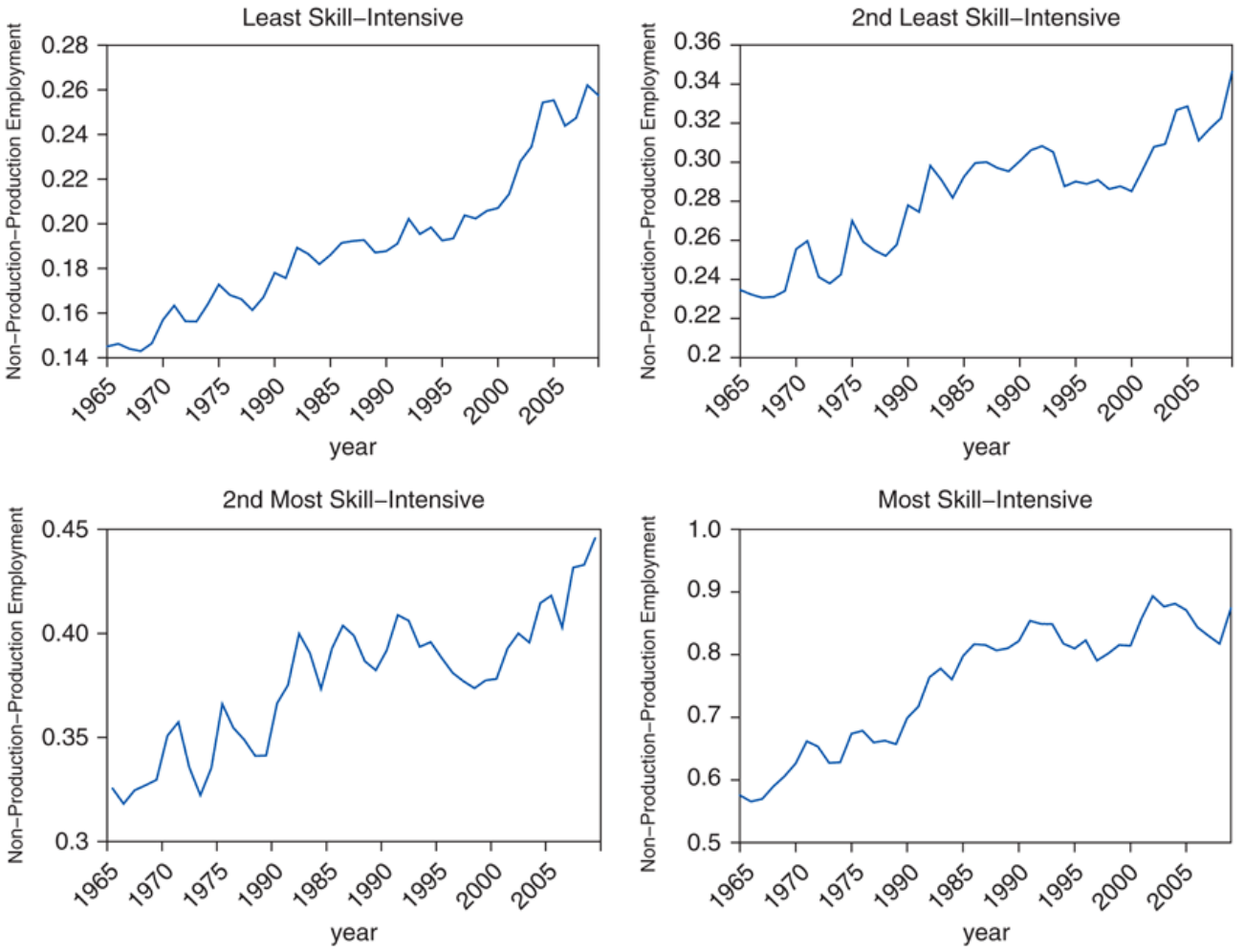


Fig. 5-11: Evolution of U.S. Non-Production–Production Employment Ratios in Four Groups of Sectors



Source: NBER-CES Manufacturing Productivity Database

Skill-Biased Technological Change and Income Inequality

- Even though skilled labor becomes relatively more expensive, in panel (b) producers in both sectors respond to the skill-biased technological change by *increasing* their employment of skilled workers relative to unskilled workers.
  - The trade explanation in panel (a) predicts an opposite response for employment in both sectors.
- A widespread increase in the skilled labor ratios for most sectors in the U.S. economy points to the skill-biased technological explanation.
- Trade likely has been an indirect contributor to increases in wage inequality, by accelerating the process of technological change.

Factor Price Equalization

- Unlike the Ricardian model, the Heckscher-Ohlin model predicts that factor prices will be equalized among countries that trade.
- Free trade equalizes relative output prices.
- Due to the connection between output prices and factor prices, see Fig. 5-6, factor prices are also equalized.
- In the real world, factor prices are not equal across countries. **Why?**

Table 5-1: Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Production Workers, 2011
United States	100
Germany	133
Japan	101
Spain	80
South Korea	53
Brazil	33
Mexico	18
China*	4

*2008

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

Factor Price Equalization

- The model assumes that trading countries produce the same goods, but countries may produce different goods if their factor ratios radically differ.
  - For example, one country might produce only cloth while the other country might produce only food.
- 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.
- The model also ignores trade barriers and transportation costs, which may prevent output prices and thus factor prices from equalizing.

Empirical Evidence on the Heckscher-Ohlin Model

- Tests on US data
  - Leontief (1953) 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 (1987) tested the Heckscher-Ohlin model on data from 27 countries and confirmed the Leontief paradox on an international level.

Table 5-2: Factor Content of U.S. Exports and Imports for 1962

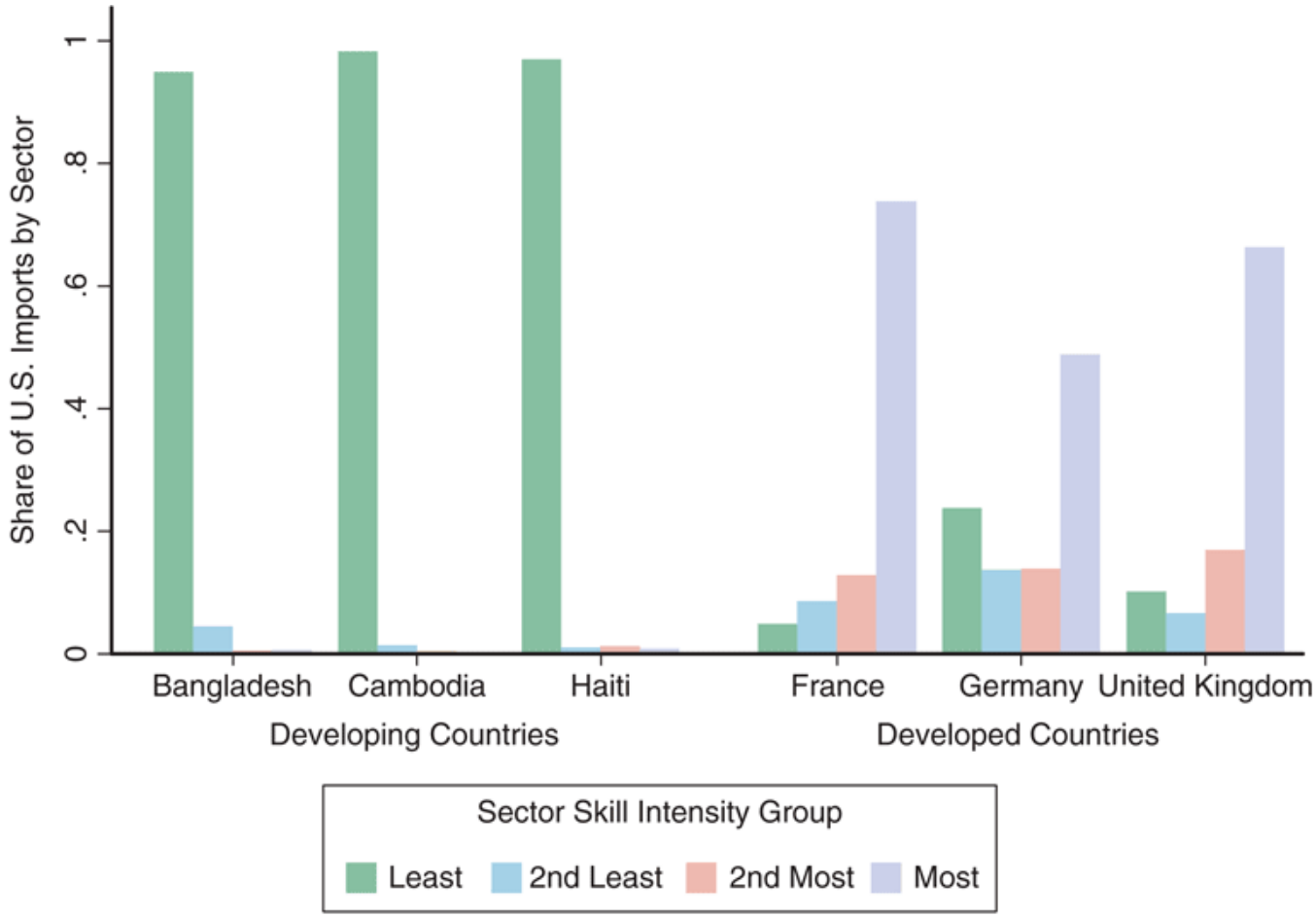
	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

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

Empirical Evidence on the Heckscher-Ohlin Model

- Because of its strict assumptions (the same technology), H-O model is not able to explain trade flows between most countries.
- Is there some evidence consistent with implications of H-O model?
- Fig. 5-12: Contrast the exports of labor-abundant, skill-scarce nations in the developing world with the exports of skill-abundant, labor-scarce (rich) nations.
  - The exports of the three developing countries to the United States are concentrated in sectors with the lowest skill-intensity.
  - The exports of the three skill abundant countries to the United States are concentrated in sectors with higher skill intensity.

Fig. 5-12: Export Patterns for a Few Developed and Developing Countries, 2008–2012



Source: NBER-CES U.S. Manufacturing Productivity Database, U.S. Census Bureau, and Peter K. Schott, "The Relative Sophistication of Chinese Exports," *Economic Policy* (2008), pp. 5–49.

Empirical Evidence on the Heckscher-Ohlin Model

- Fig. 5-13: Compare how exports change when a country such as China grows and becomes relatively more skill-abundant:
  - The concentration of exports in high-skill sectors steadily increases over time.
  - In the most recent years, the greatest share of exports is concentrated in the highest skill-intensity sectors, whereas exports were concentrated in the lowest skill-intensity sectors in the earlier years.

Fig. 5-13: Changing Pattern of Chinese Exports over Time

Source: NBER-CES U.S. Manufacturing Productivity Database, U.S. Census Bureau, and Peter K. Schott, "The Relative Sophistication of Chinese Exports," *Economic Policy* (2008), pp. 5–49.

Summary

1. Substitution of factors used in the production process generates a curved PPF.
   - When an economy produces a low quantity of a good, the opportunity cost of producing that good is low.
2. When an economy produces the most value it can from its resources, the opportunity cost of producing a good equals the relative price of that good in markets.
3. An increase in the relative price of a good causes the real wage or real rental rate of the factor used intensively in the production of that good to increase,
   - while the real wage and real rental rates of other factors of production decrease.

Summary

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 increases, and the supply of the other good decreases.
5. An economy exports goods that are relatively intensive in its relatively abundant factors of production and imports goods that are relatively intensive in its relatively scarce factors of production.
6. The model predicts that owners of abundant factors gain, while owners of scarce factors lose from trade.

Summary

7. A country as a whole is predicted to be better off with trade, so winners could in theory compensate the losers within each country.
8. The Heckscher-Ohlin model predicts that relative output prices and factor prices will equalize, neither of which occurs in the real world.
9. Empirical support of the Heckscher-Ohlin model is weak except for cases involving trade between high-income countries and low/middle- income countries.