Chapter 5

Resources and Trade: The Heckscher-Ohlin Model

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THEORY & POLICY

NINE EDITION
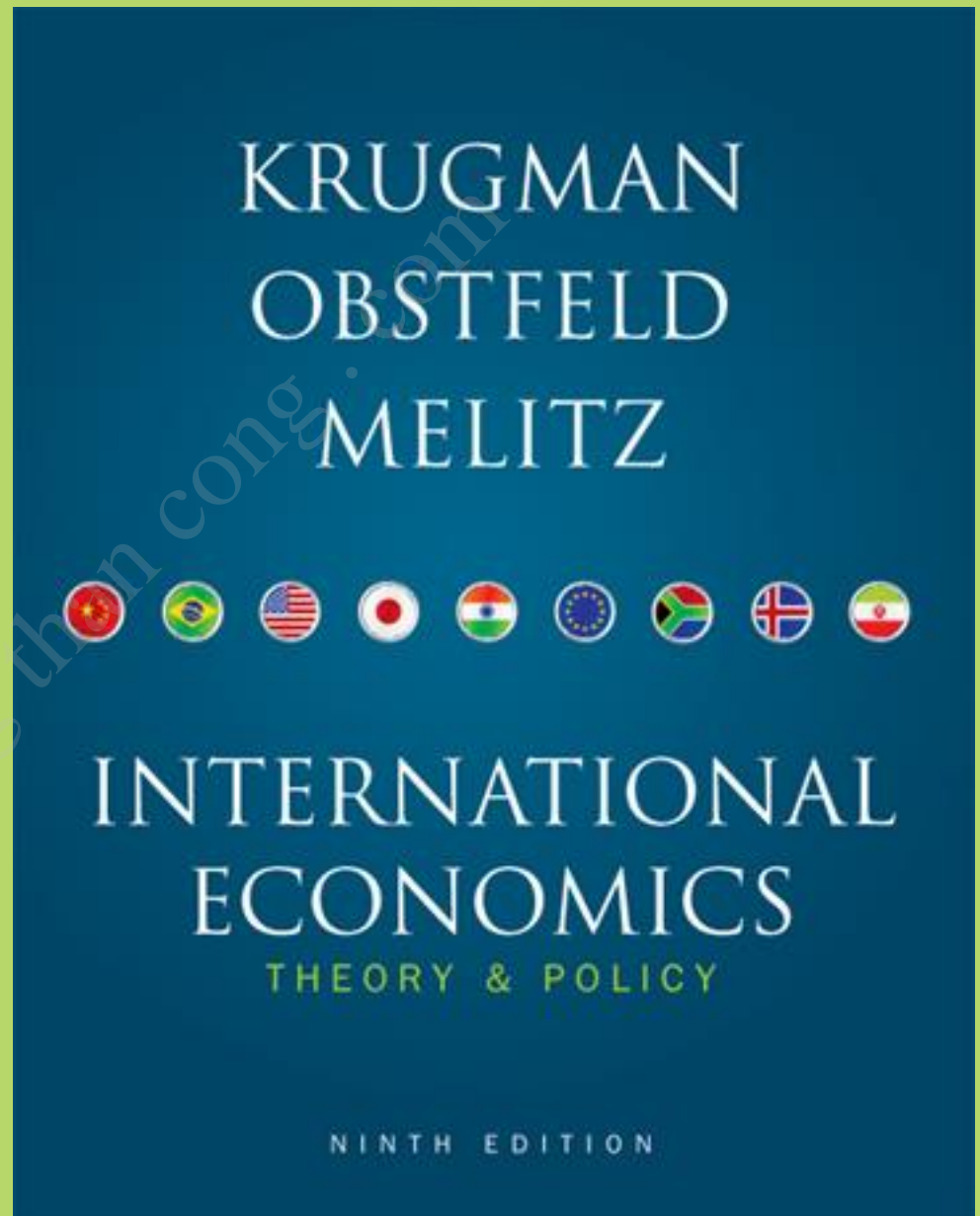
Preview

- Production possibilities

- Changing the mix of inputs

- Relationships among factor prices and goods prices, and resources and output

- Trade in the Heckscher-Ohlin model

- Factor price equalization

- Trade and income distribution

- Empirical evidence

Introduction

- The Ricardian theory (Ch. 3) showed how trade can arise because of differences in labor productivity

- The Heckscher-Ohlin theory argues that, in addition, trade also occurs due to
    - differences in the availability of labor, labor skills, physical capital, capital, or other factors of production across countries, and
    - differences in the needs for the various resources across industries
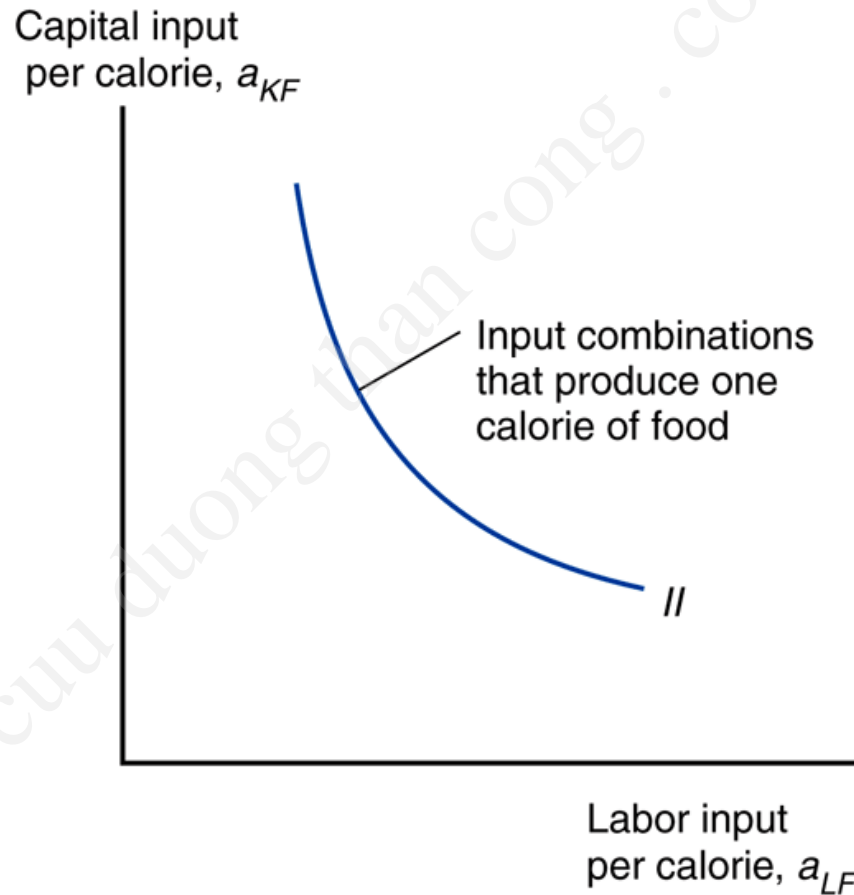
Two Factor Heckscher-Ohlin Model

1. Two countries: home and foreign.
2. Two goods: cloth and food.
3. Two factors of production: labor and capital.
4. Consumer preferences are identical for all individuals
5. The same technological knowledge is available everywhere
6. The mix of labor and capital used in production varies across goods.
7. The supply of labor and capital in each country is constant and varies across countries.
8. Both labor and capital can move across sectors.

Choosing the Mix of Inputs

- To produce a given amount of cloth (or food), a firm may choose different amounts of labor and capital depending on the wage, *w*, paid to labor and the rental rate, *r*, paid when renting capital.

- When 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.
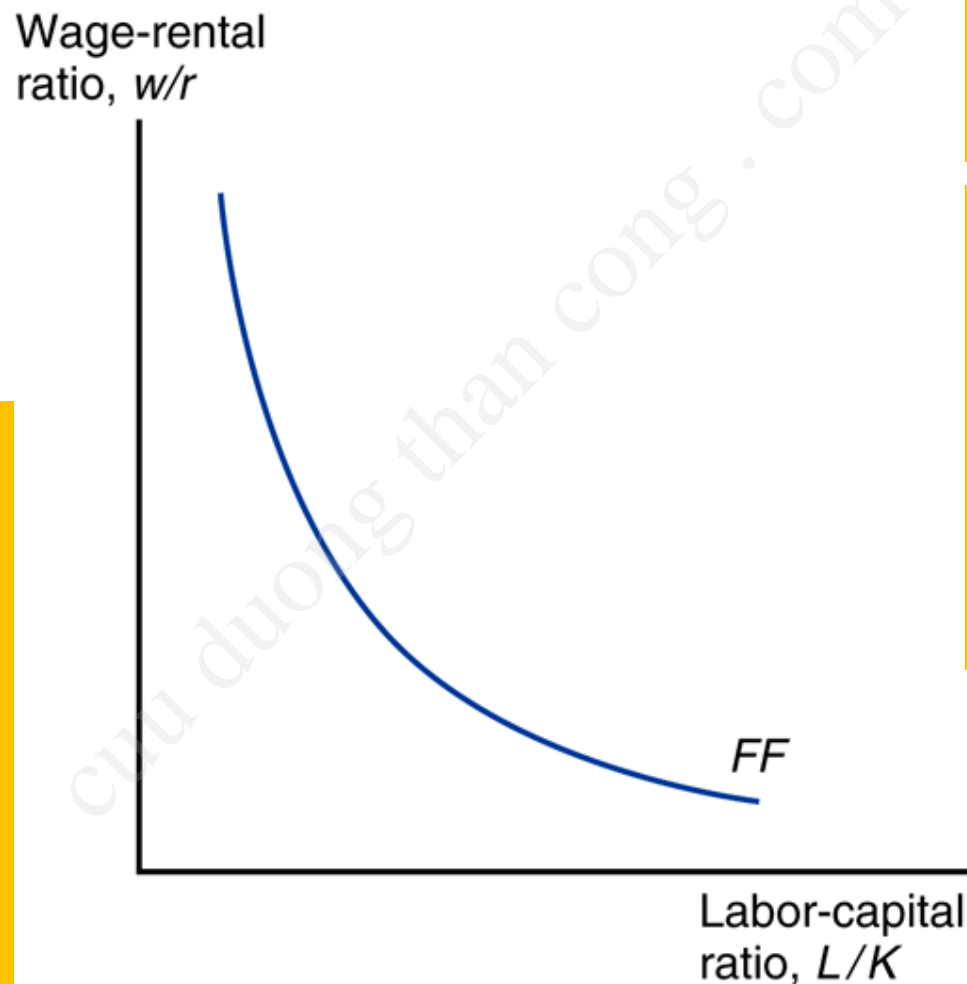
Fig. 5-4: Input Possibilities in Food Production

Capital input per calorie, a_{KF}

Input combinations that produce one calorie of food

II

Labor input per calorie, a_{LF}

Choosing the Mix of Inputs

- *Assumption*: For any given values of *w* and *r*, cloth production uses more labor relative to capital than food production uses:

  $a_{LC}/a_{KC} > a_{LF}/a_{KF}$ or $L_C/K_C > L_F/K_F$

- That is, production of cloth is relatively labor intensive, while production of food is relatively capital intensive.
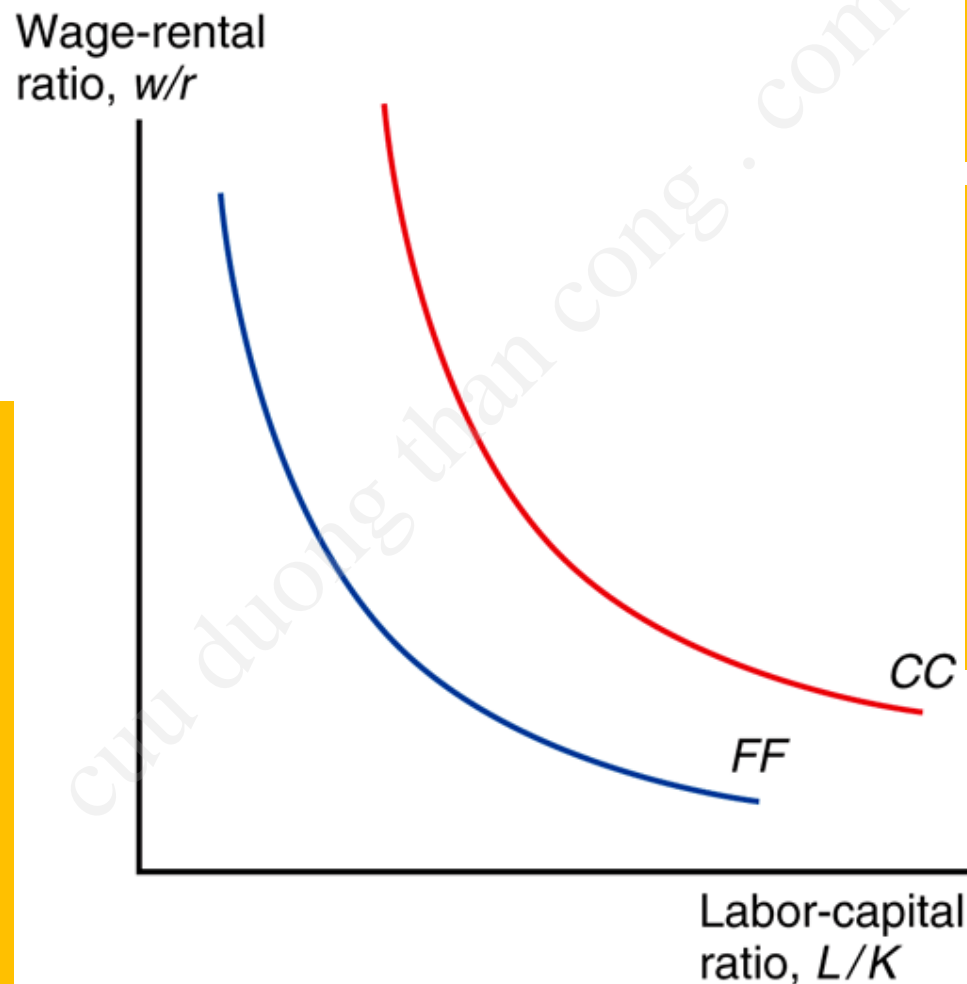
Fig. 5-5: Factor Prices and Input Choices

Relative Factor Demand Curve

Remember: Cloth is labor intensive, while food is capital intensive

As both countries use the same technology, the same relative factor demand curve is true in both countries.

Fig. 5-5: Factor Prices and Input Choices

Wage-rental ratio, *w/r*

CC

FF

Labor-capital ratio, *L/K*

**Relative Factor Demand Curve**

Remember: Cloth is labor intensive, while food is capital intensive

As both countries use the same technology, the same relative factor demand curve is true in both countries.

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.

- Therefore, an increase in *w/r* causes an increase in P_C/P_W.

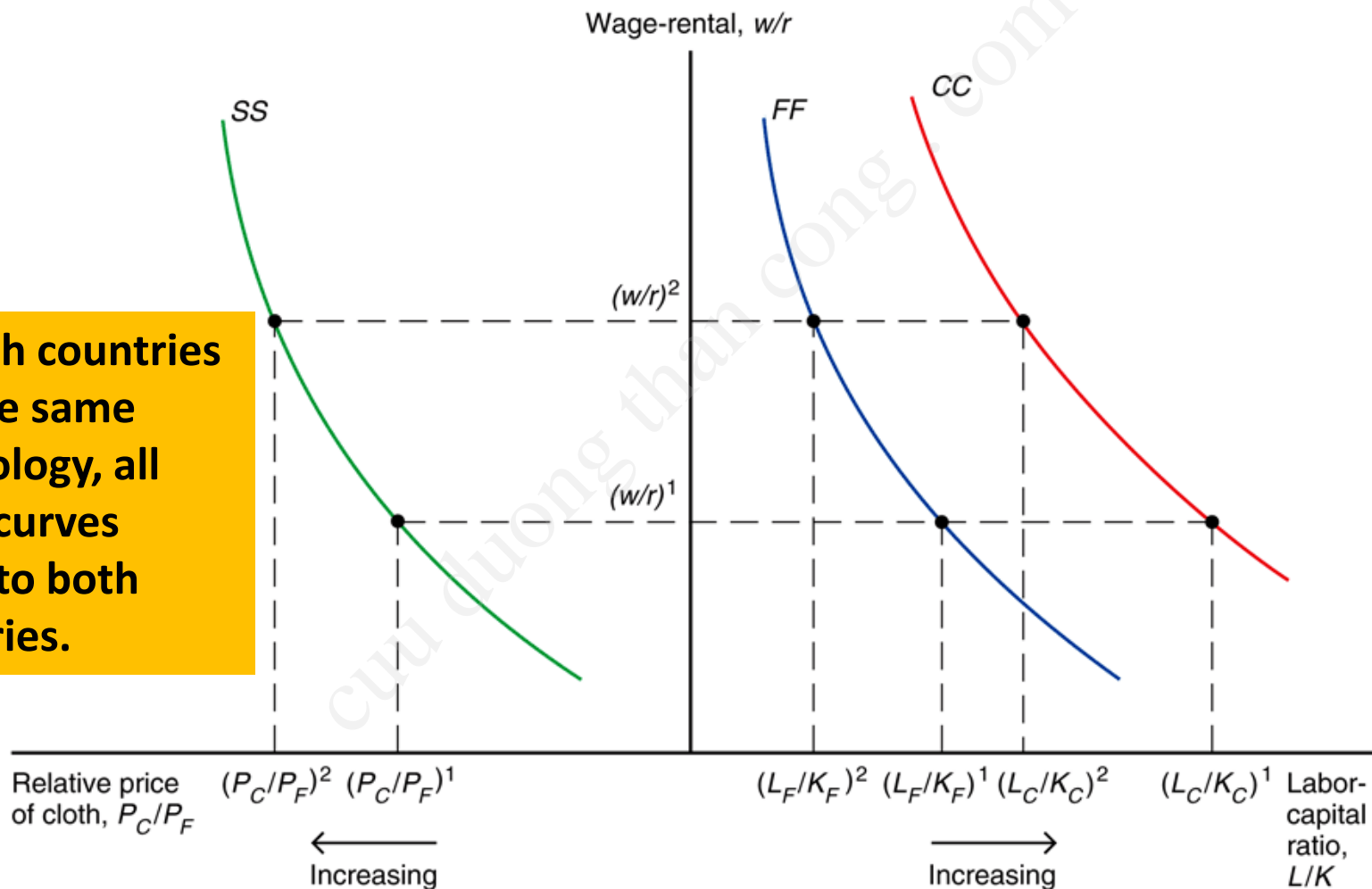# Fig. 5-6: Factor Prices and Goods Prices
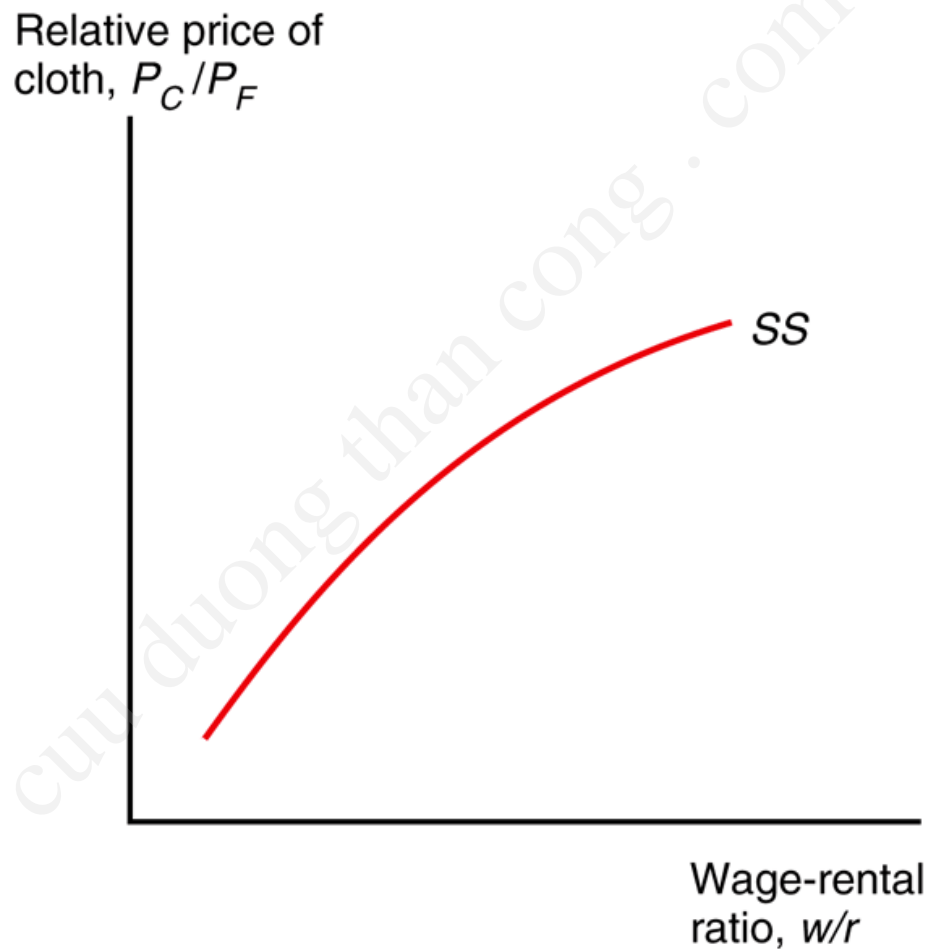
As both countries use the same technology, the same *SS* curve is true in both countries.

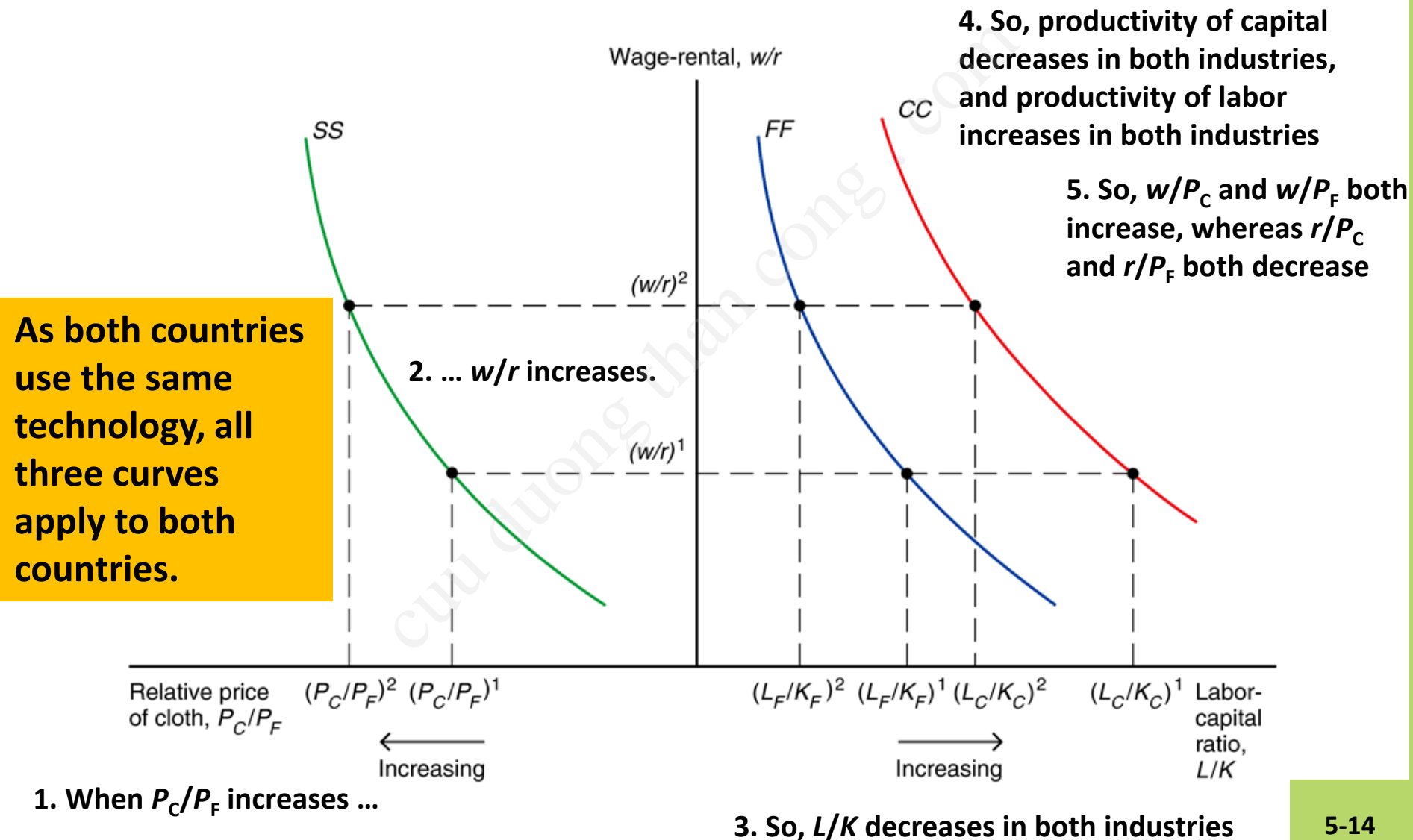# Factor Prices and Goods Prices (cont.)

- **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

As both countries use the same technology, all three curves apply to both countries.

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

4. So, productivity of capital decreases in both industries, and productivity of labor increases in both industries

5. So, w/P_C and w/P_F both increase, whereas r/P_C and r/P_F both decrease

Wage-rental, w/r

SS

FF

CC

$(w/r)^2$

$(w/r)^1$

2. … w/r increases.

As both countries use the same technology, all three curves apply to both countries.

Relative price of cloth, P_C/P_F

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

$(L_F/K_F)^2$ $(L_F/K_F)^1$ $(L_C/K_C)^2$

$(L_C/K_C)^1$ Labor-capital ratio, L/K

← Increasing

Increasing →

1. When P_C/P_F increases …

3. So, L/K decreases in both industries

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Stolper-Samuelson Theorem

- When P_C/P_F ↑, w/r ↑.
- So, L/K ↓ in both industries
- So, productivity of capital ↓ in both industries, and
- productivity of labor ↑ in both industries.
- So, w/P_C and w/P_F both ↑, whereas
- r/P_C and r/P_F both ↓.

- When P_C/P_F ↓, w/r ↓.
- So, L/K ↑ in both industries
- So, productivity of capital ↑ in both industries, and
- productivity of labor ↓ in both industries.
- So, w/P_C and w/P_F both ↓, whereas
- r/P_C and r/P_F both ↑.

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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*.

Resources and Output

- 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.

- 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.
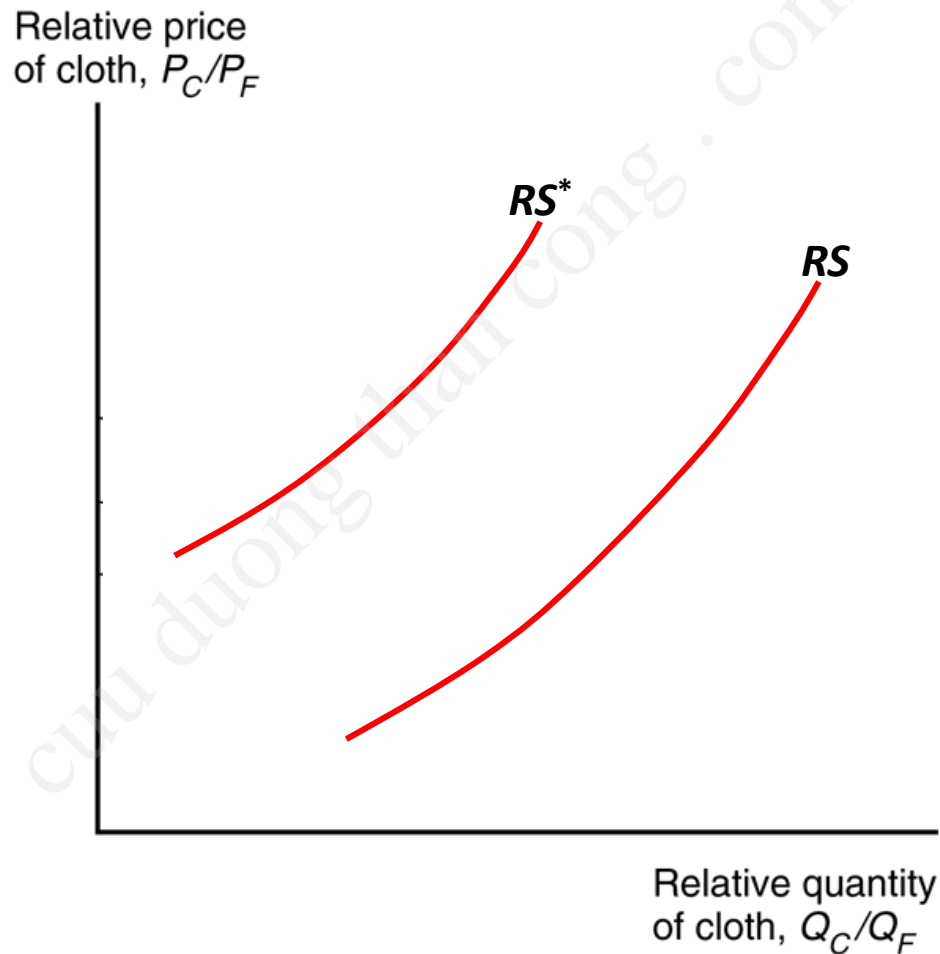
Resources and Output

- An economy with a *high ratio of labor to capital* produces a *high output of cloth relative to food*.

- *Assumption*: Home is **relatively abundant** in labor and Foreign is relatively abundant in capital:
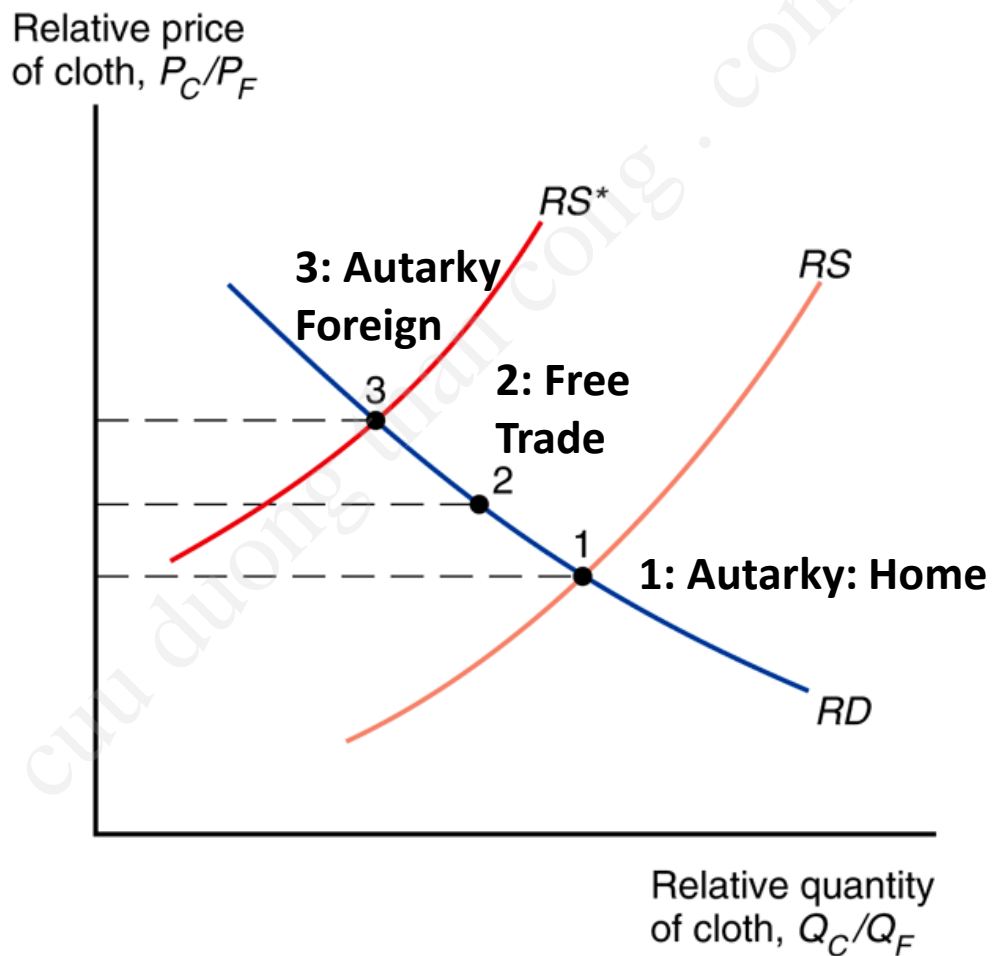
$$L/K > L*/K*$$

  - 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*.

Relative Supply Curves

Assumption: Home is relatively abundant in labor and Foreign is relatively abundant in capital

Relative price
of cloth, P_C/P_F

RS^*

RS

Relative quantity
of cloth, Q_C/Q_F

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

From Autarky to Free Trade

- So, under our assumptions,

- The autarky relative price of cloth P_C/P_F will be lower in Home and higher in Foreign.

- Equivalently, the autarky relative price of food P_F/P_C will be higher in Home and lower in Foreign.

- Therefore, under free trade, Home will export cloth to Foreign,

- and Foreign will export food to Home

From Autarky to Free Trade

- Remember that we assumed
- Cloth is labor intensive and food is capital intensive
- Home is labor abundant and Foreign is capital abundant
- So, we see that the labor abundant country (Home) exports the labor intensive good (Cloth), and
- the capital abundant country (Foreign) exports the capital intensive good (Food)

From Autarky to Free Trade

- **Heckscher-Ohlin Theorem: Each country exports the good that relatively intensively uses the factor of production relatively abundant in that country**

Fig. 5-9: Trade Leads to a Convergence of Relative Prices
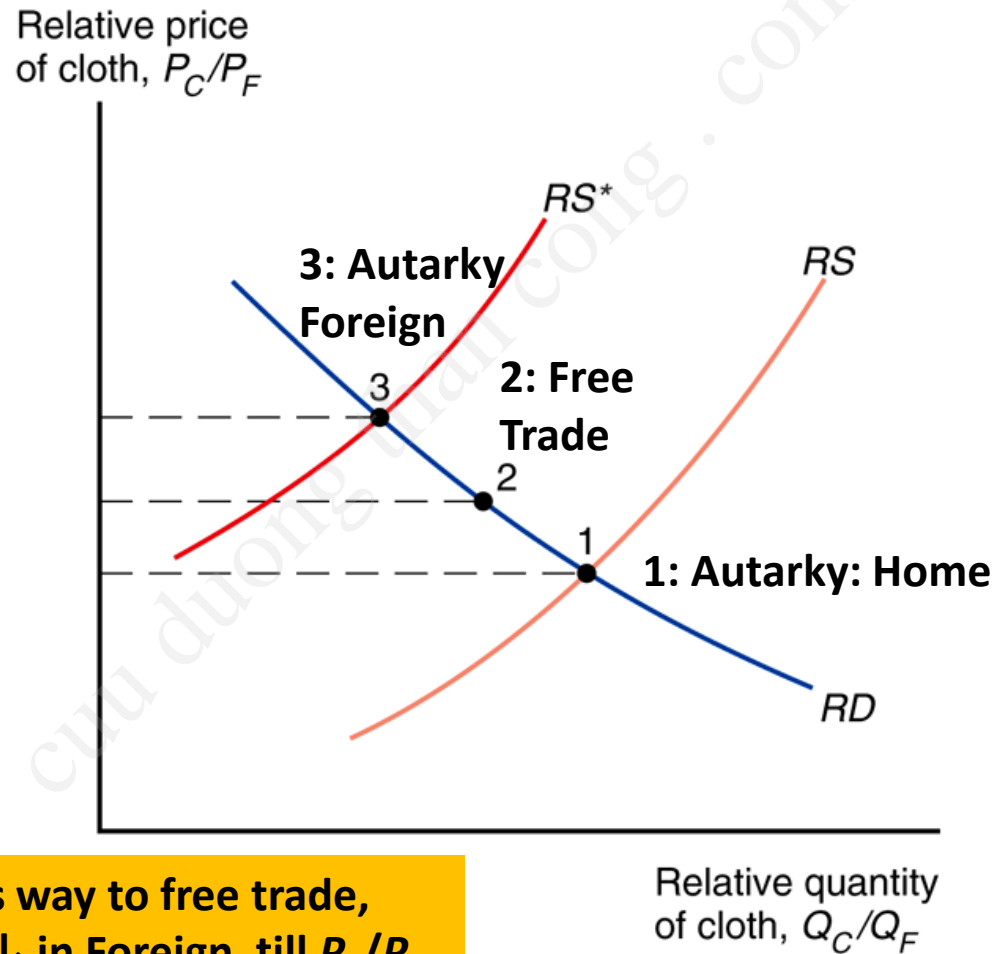
So, when autarky gives way to free trade, P_C/P_F ↑ in Home and ↓ in Foreign, till P_C/P_F becomes the same in the two countries .

Stolper-Samuelson Theorem

- When $P_C/P_F \uparrow$, $w/r \uparrow$.
- So, $L/K \downarrow$ in both industries
- So, productivity of capital $\downarrow$ in both industries, and
- productivity of labor $\uparrow$ in both industries.
- So, w/P_C and w/P_F both $\uparrow$, whereas
- r/P_C and r/P_F both $\downarrow$.

- When $P_C/P_F \downarrow$, $w/r \downarrow$.
- So, $L/K \uparrow$ in both industries
- So, productivity of capital $\uparrow$ in both industries, and
- productivity of labor $\downarrow$ in both industries.
- So, w/P_C and w/P_F both $\downarrow$, whereas
- r/P_C and r/P_F both $\uparrow$.

HOME labor abundant
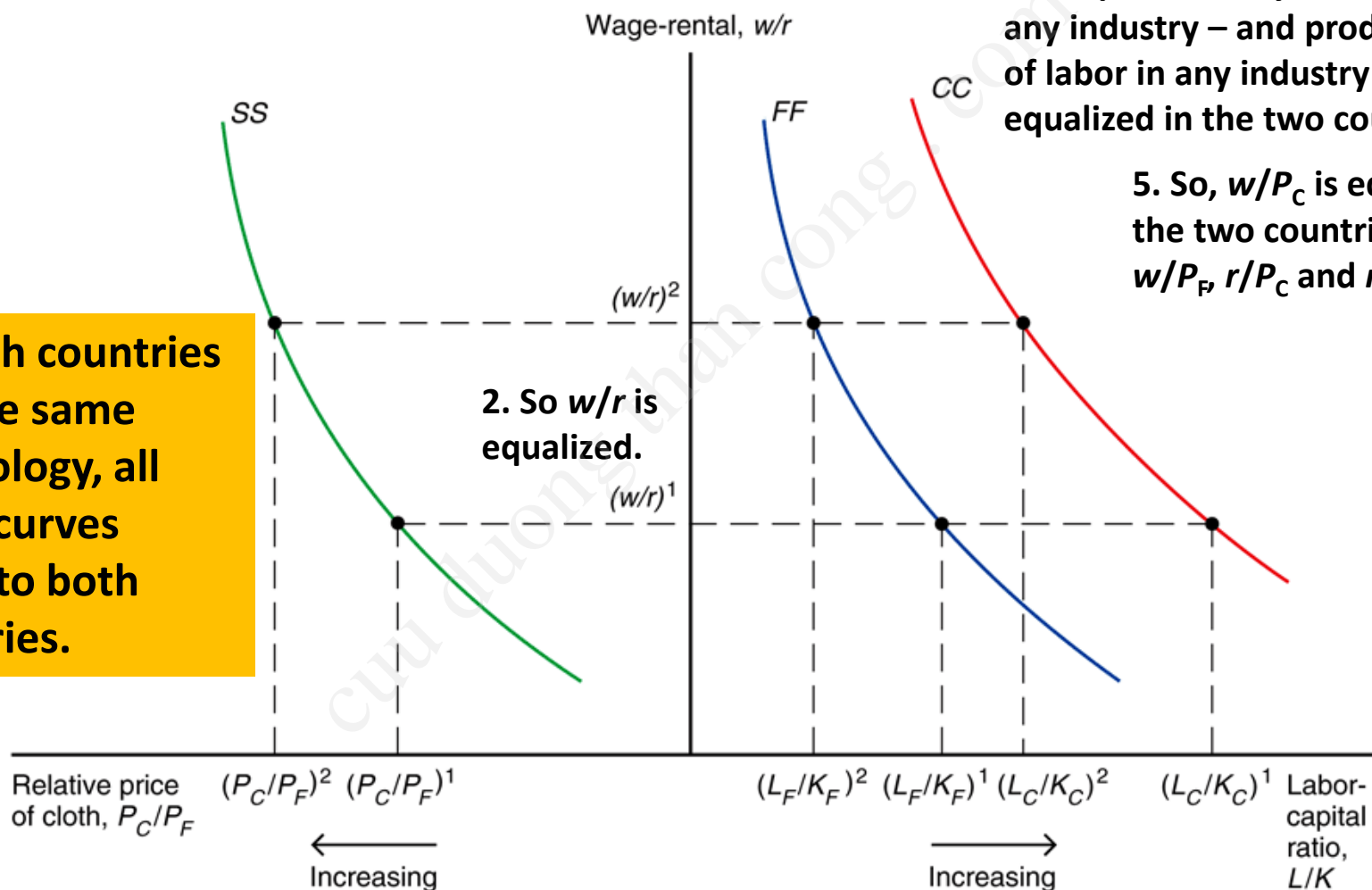
FOREIGN capital abundant

From Autarky to Free Trade

- Therefore, we see that **in each country, the relatively abundant factor of production gains – and the relatively scarce resource loses – from globalization**

The Factor Price Equalization Theorem

4. So, productivity of capital in any industry – and productivity of labor in any industry – is equalized in the two countries

5. So, w/P_C is equalized in the two countries, as are w/P_F, r/P_C and r/P_F

As both countries use the same technology, all three curves apply to both countries.

2. So w/r is equalized.

Wage-rental, w/r

SS

FF

CC

$(w/r)^2$

$(w/r)^1$

Relative price of cloth, P_C/P_F

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

$(L_F/K_F)^2$ $(L_F/K_F)^1$ $(L_C/K_C)^2$ $(L_C/K_C)^1$ Labor-capital ratio, L/K

← Increasing

Increasing →

1. Under free trade, P_C/P_F is equalized in the two countries.

3. So, L/K in any industry is equalized in the two countries.

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, factor prices are also equalized.

- Trade increases the demand of goods produced by relatively abundant factors, indirectly increasing the demand of these factors, raising the prices of the relatively abundant factors.

Factor Price Equalization (cont.)

- In the real world, factor prices are *not* equal across countries.

- The model assumes that trading countries produce the same goods, but countries may produce different goods if their factor ratios radically differ.

- 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.

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

TABLE 5-1	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.*

Factor Price Equalization (cont.)

- The model also ignores trade barriers and transportation costs, which may prevent output prices and thus 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/rental 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 relatively abundant factors will gain from trade and owners of relatively scarce factors will lose from trade.

  – 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 on 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.

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

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.

Table 5-3: Testing the Heckscher-Ohlin Model

TABLE 5-3	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.

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.

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

TABLE 5-4	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, "The Care of the Missing Trade and Other Mysteries," *American Economic Review* 85 (December 1995), pp. 1029–1046.

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

- Looking at changes in patterns of exports between developed (high income) and developing (low/middle income) countries supports the theory.

- US imports from Bangladesh are highest in low-skill-intensity industries, while US imports from Germany are highest in high- skill-intensity industries.

Fig. 5-12: Skill Intensity and the Pattern of U.S. Imports from Two Countries
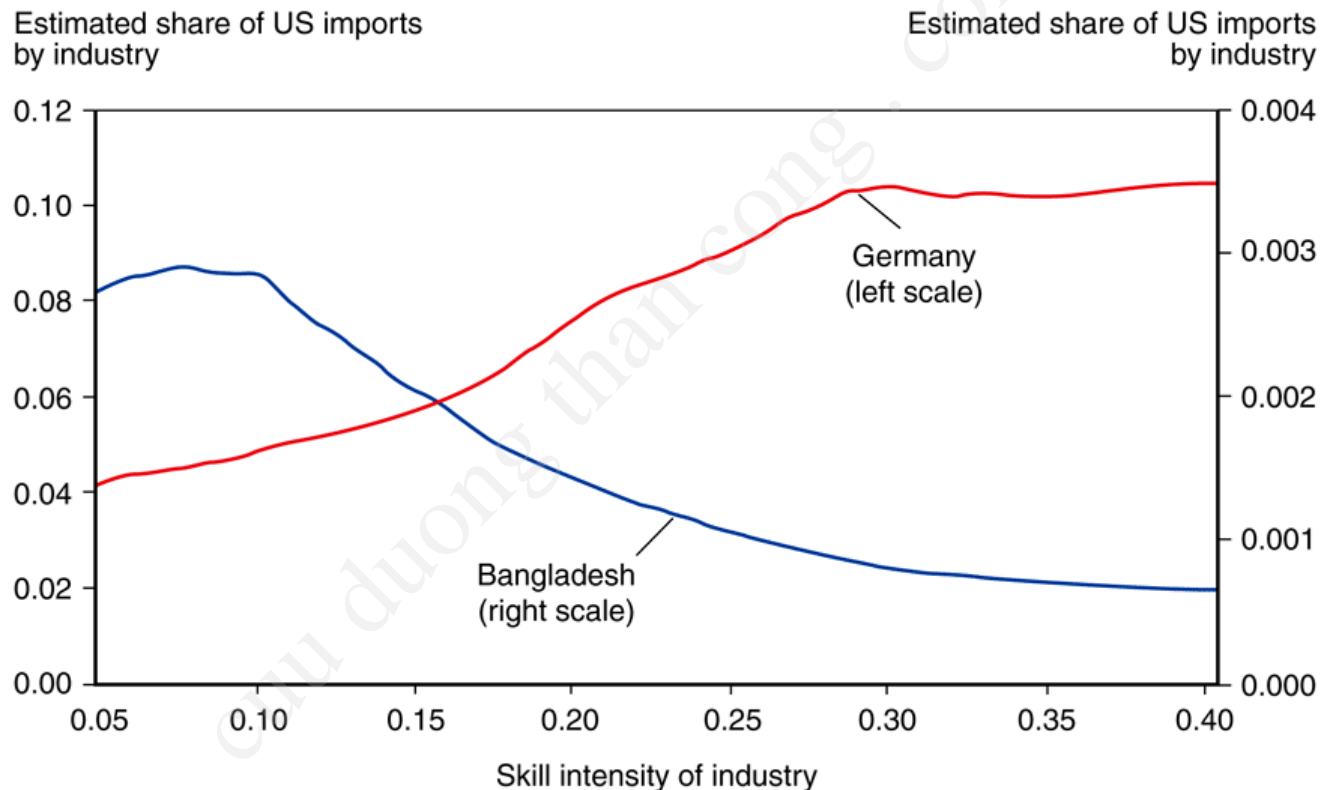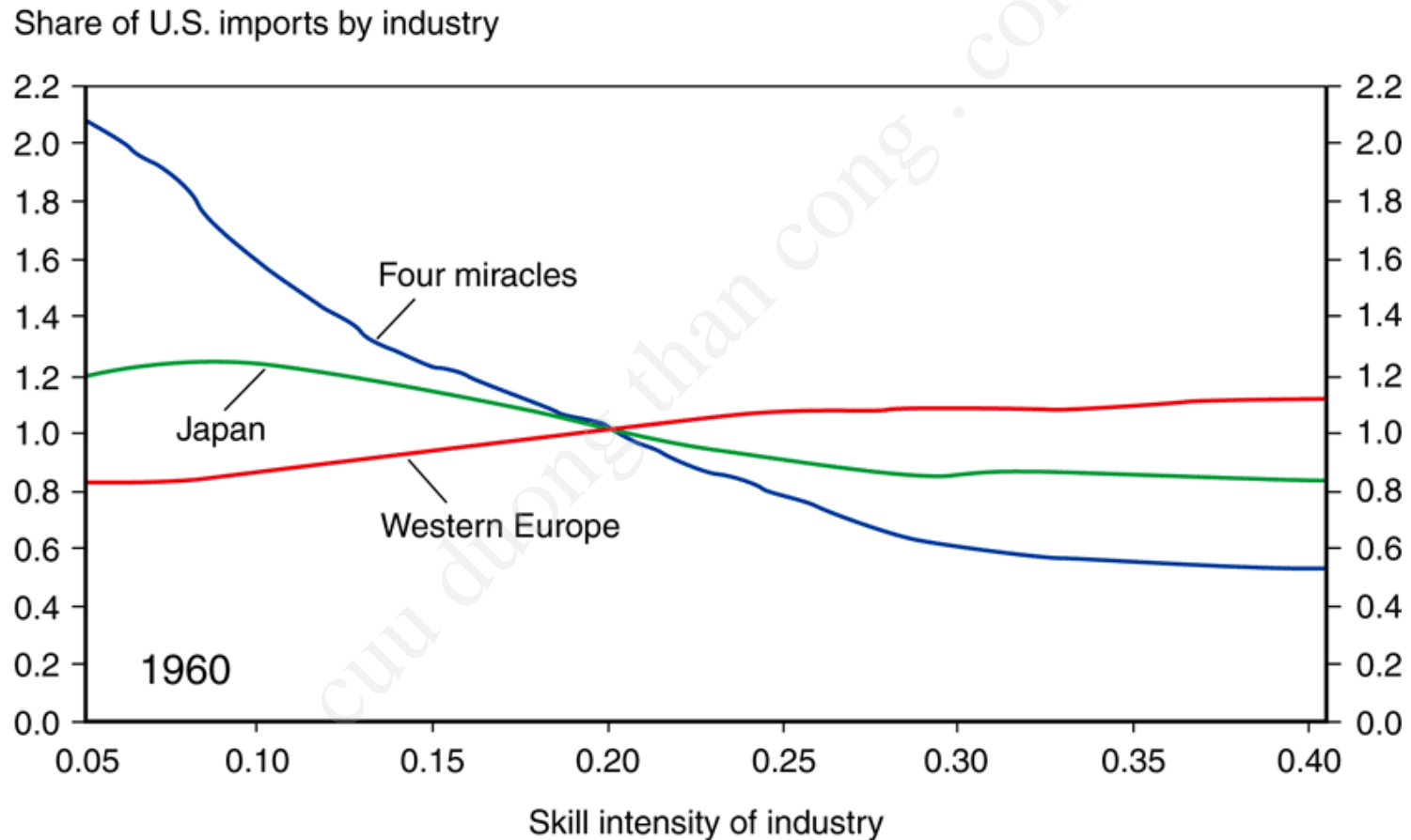

Source: John Romalis, "Factor Proportions and the Structure of Commodity Trade," American Economic Review 94 (March 2004), pp. 67–97.

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

- As Japan and the four Asian "miracle" countries became more skill-abundant, U.S. imports from these countries shifted from less skill-intensive industries toward more skill-intensive industries.
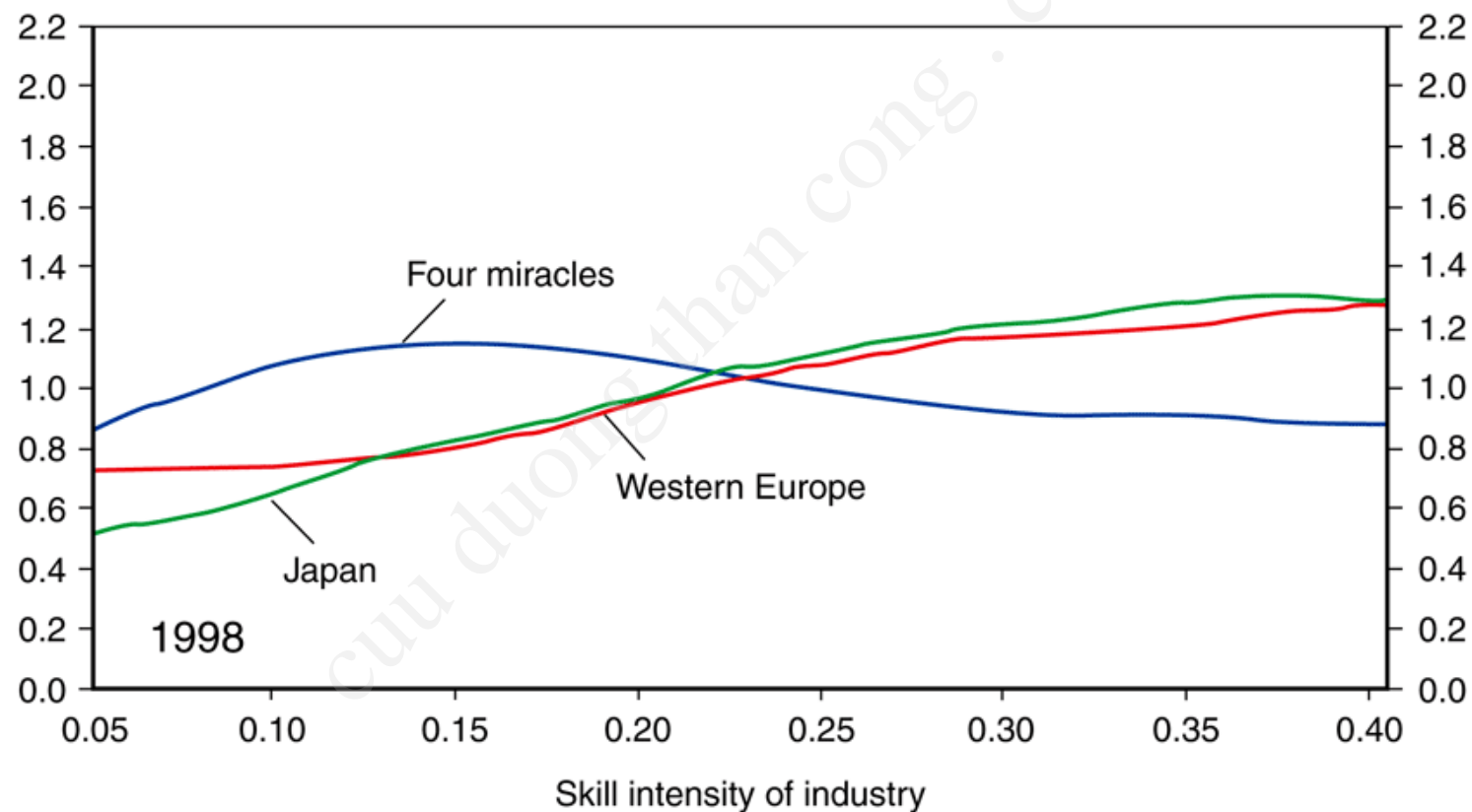
Fig. 5-13: Changing Patterns of Comparative Advantage

Share of U.S. imports by industry

(a) 1960

Fig. 5-13: Changing Patterns of Comparative Advantage (cont.)

(a) 1998