# Public Affairs 856
# Trade, Competition, and Governance in a Global Economy

Lecture 5-6

2/1-2/6/2017

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# Outline

1. **Heckscher-Ohlin Model**
2. **Testing the Heckscher-Ohlin Model**
3. **Effects of Trade on Factor Prices**

## Introduction

In this chapter, we outline the **Heckscher-Ohlin (HO) model**, a model that assumes that trade occurs because countries have different resources.

- Canada has a large amount of land and therefore exports agricultural and forestry products, as well as petroleum.
- The United States, Western Europe, and Japan have many highly skilled workers and much capital and these countries export sophisticated services and manufactured goods.
- China and other Asian countries have a large number of workers and moderate but growing amounts of capital and they export less sophisticated manufactured goods.

# 1 Heckscher-Ohlin Model

## Assumptions of the Heckscher-Ohlin Model

**Assumption 1:** Two factors of production, labor and capital, can move freely between the industries.

**Assumption 2:** Shoe production is **labor-intensive**; that is, it requires more labor per unit of capital to produce shoes than computers.

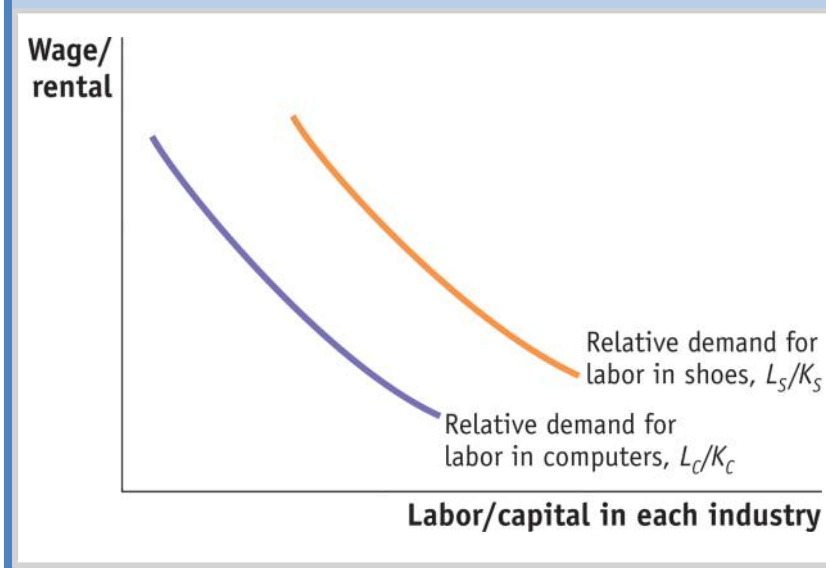
### Labor Intensity of Each Industry

Shoe production being more labor-intensive than computers implies:

$$L_S/K_S > L_C/K_C.$$

These two curves slope down just like regular demand curves, but in this case, they are *relative* demand curves for labor.

FIGURE 4-1



## 1 Heckscher-Ohlin Model

### Assumptions of the Heckscher-Ohlin Model

**Assumption 3:** Foreign is labor-abundant, by which we mean that the labor–capital ratio in Foreign exceeds that in Home,

$$\bar{L}^*/\bar{K}^* > \bar{L}/\bar{K}.$$

Equivalently, Home is capital-abundant, so that $\bar{K}/\bar{L} > \bar{K}^*/\bar{L}^*$

**Assumption 4:** The final outputs, shoes and computers, can be traded freely (i.e., without any restrictions) between nations, but labor and capital do not move between countries.

**Assumption 5:** The technologies used to produce the two goods are identical across the countries.

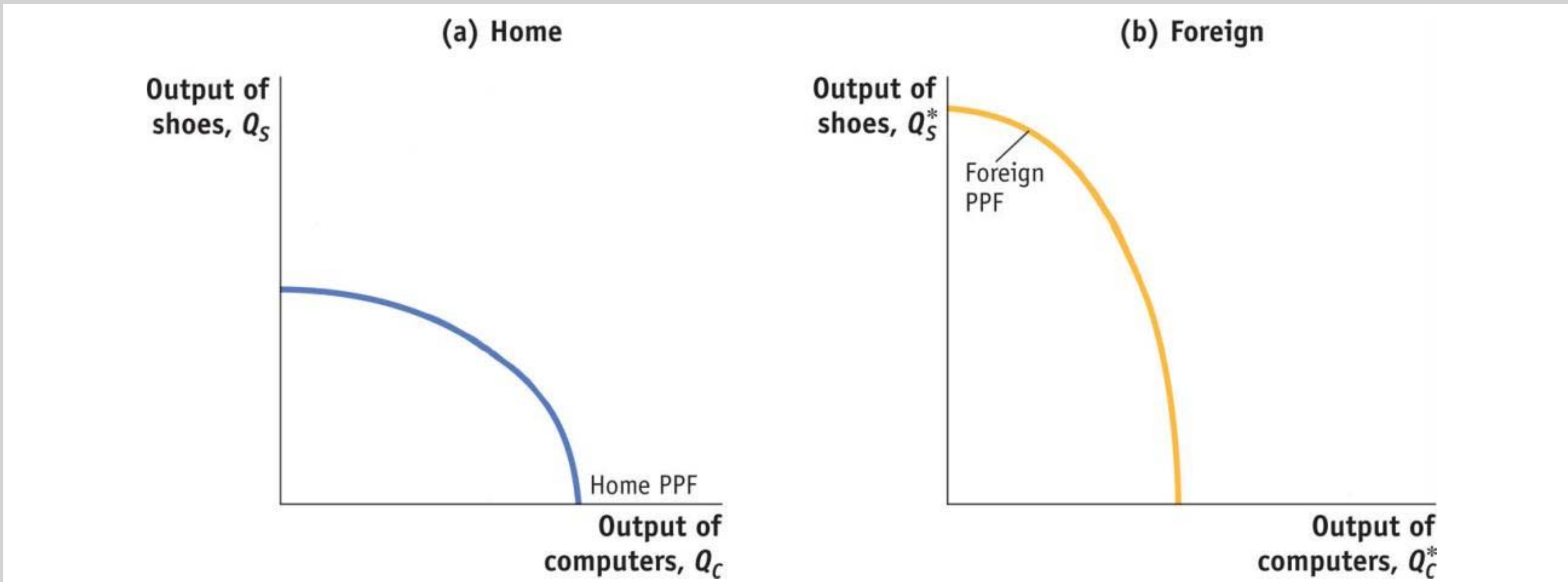
**Assumption 6:** Consumer tastes are the same across countries, and preferences for computers and shoes do not vary with a country's level of income.

# 1 Heckscher-Ohlin Model

## No-Trade Equilibrium

### Production Possibilities Frontiers, Indifference Curves, and No-Trade Equilibrium Price

FIGURE 4-2 (1 of 3) No-Trade Equilibria in Home and Foreign




The Home production possibilities frontier (PPF) is shown in panel (a), and the Foreign PPF is shown in panel (b).

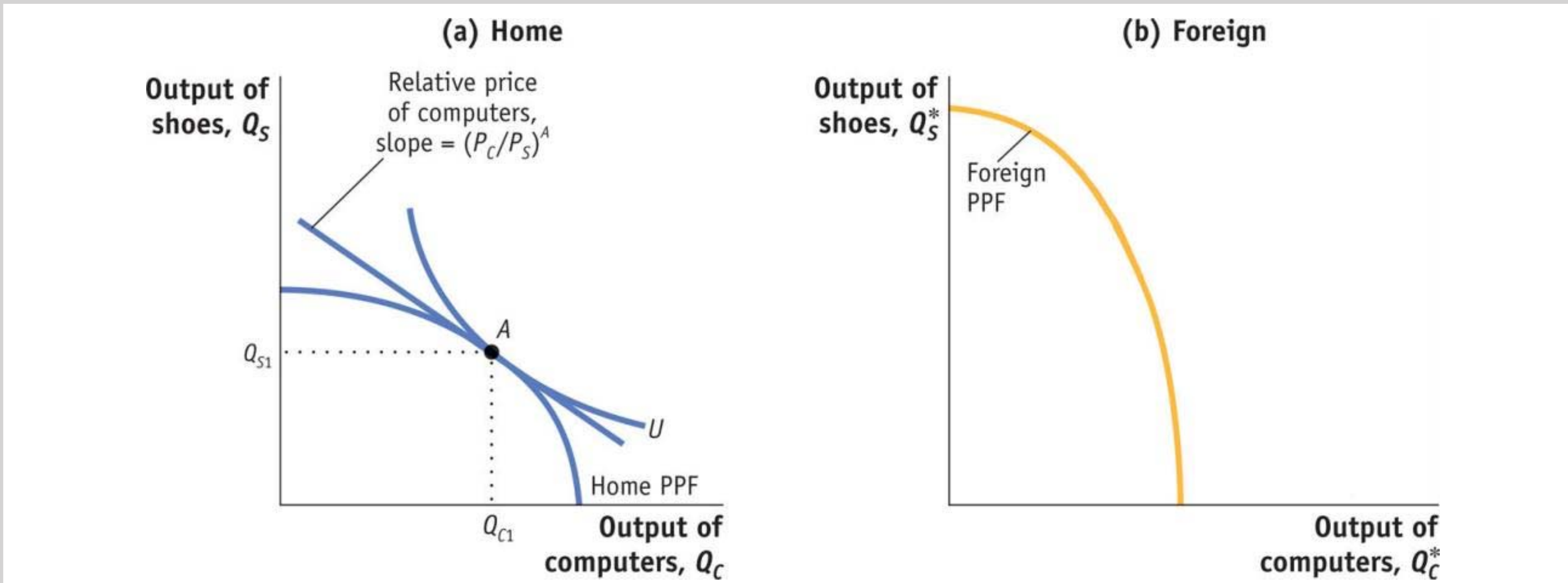
Because Home is capital abundant and computers are capital intensive, the Home PPF is skewed toward computers.

# 1 Heckscher-Ohlin Model

## No-Trade Equilibrium

### Production Possibilities Frontiers, Indifference Curves, and No-Trade Equilibrium Price

FIGURE 4-2 (2 of 3) No-Trade Equilibria in Home and Foreign (continued)




Home preferences are summarized by the indifference curve, *U*.

The Home no-trade (or autarky) equilibrium is at point *A*.

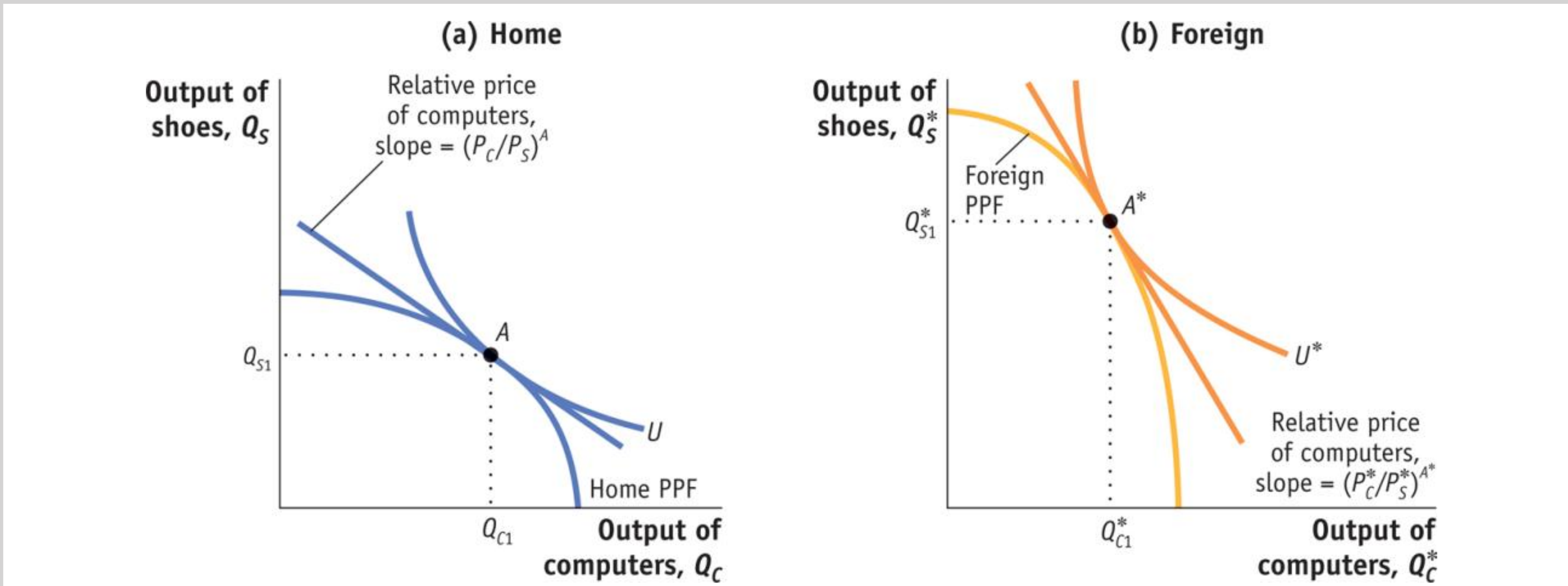
The flat slope indicates a low relative price of computers, $(P_C/P_S)^A$.

# 1 Heckscher-Ohlin Model

## No-Trade Equilibrium

### Production Possibilities Frontiers, Indifference Curves, and No-Trade Equilibrium Price

FIGURE 4-2 (3 of 3) No-Trade Equilibria in Home and Foreign (continued)




Foreign is labor-abundant and shoes are labor-intensive, so the Foreign PPF is skewed toward shoes. Foreign preferences are summarized by the indifference curve, $U^*$.

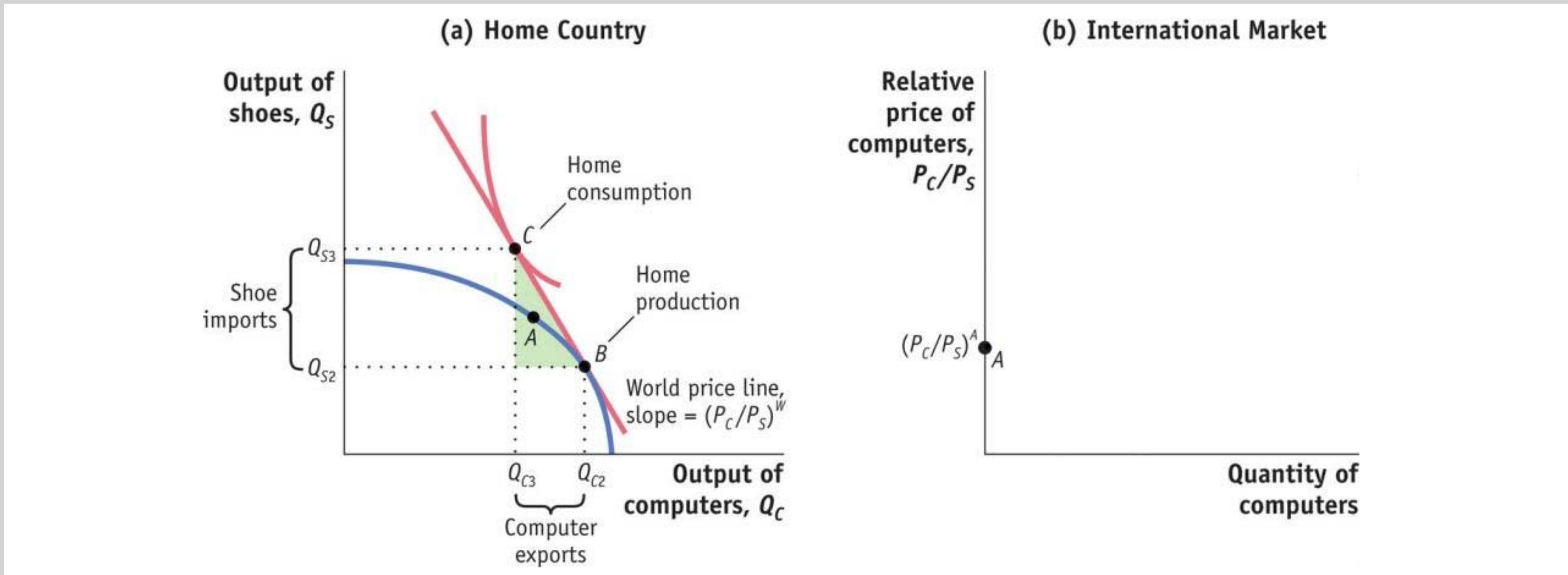
The Foreign no-trade equilibrium is at point $A^*$, with a higher relative price of computers, as indicated by the steeper slope of $(P^*_C/P^*_S)^{A^*}$.

# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Home Equilibrium with Free Trade

FIGURE 4-3 (1 of 2) International Free-Trade Equilibrium at Home




At the free-trade world relative price of computers, $(P_C/P_S)^W$, Home produces at point *B* in panel (a) and consumes at point *C*, exporting computers and importing shoes. Point *A* is the no-trade equilibrium.

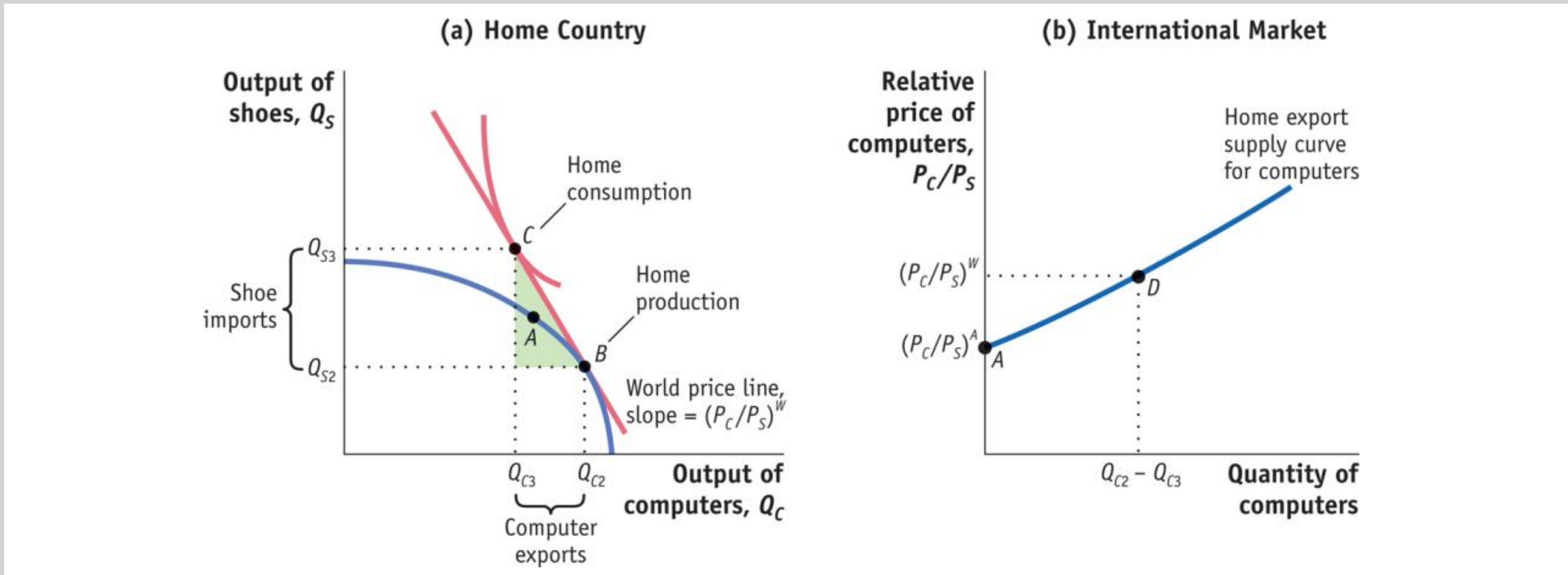
The "trade triangle" has a base equal to the Home exports of computers (the difference between the amount produced and the amount consumed with trade, $(Q_{C2} - Q_{C3})$.

# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Home Equilibrium with Free Trade

FIGURE 4-3 (2 of 2) International Free-Trade Equilibrium at Home (continued)




The height of this triangle is the Home imports of shoes (the difference between the amount consumed of shoes and the amount produced with trade, $Q_{S3} - Q_{S2}$).

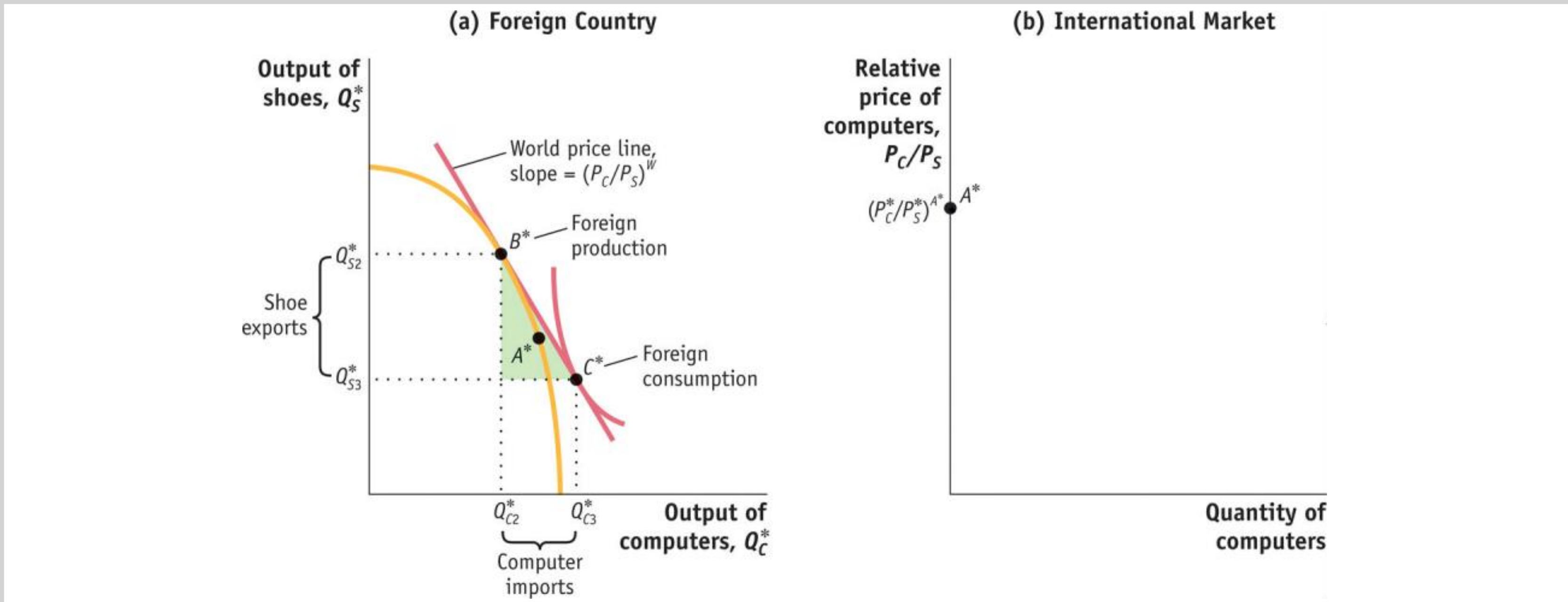
In panel (b), we show Home exports of computers equal to zero at the no-trade relative price, $(P_C/P_S)^A$, and equal to $(Q_{C2} - Q_{C3})$ at the free-trade relative price, $(P_C/P_S)^W$.

# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Foreign Equilibrium with Free Trade

FIGURE 4-4 (1 of 2) International Free-Trade Equilibrium in Foreign




At the free-trade world relative price of computers, $(P_C/P_S)^W$, Foreign produces at point $B^*$ in panel (a) and consumes at point $C^*$, importing computers and exporting shoes. Point $A^*$ is the no-trade equilibrium.

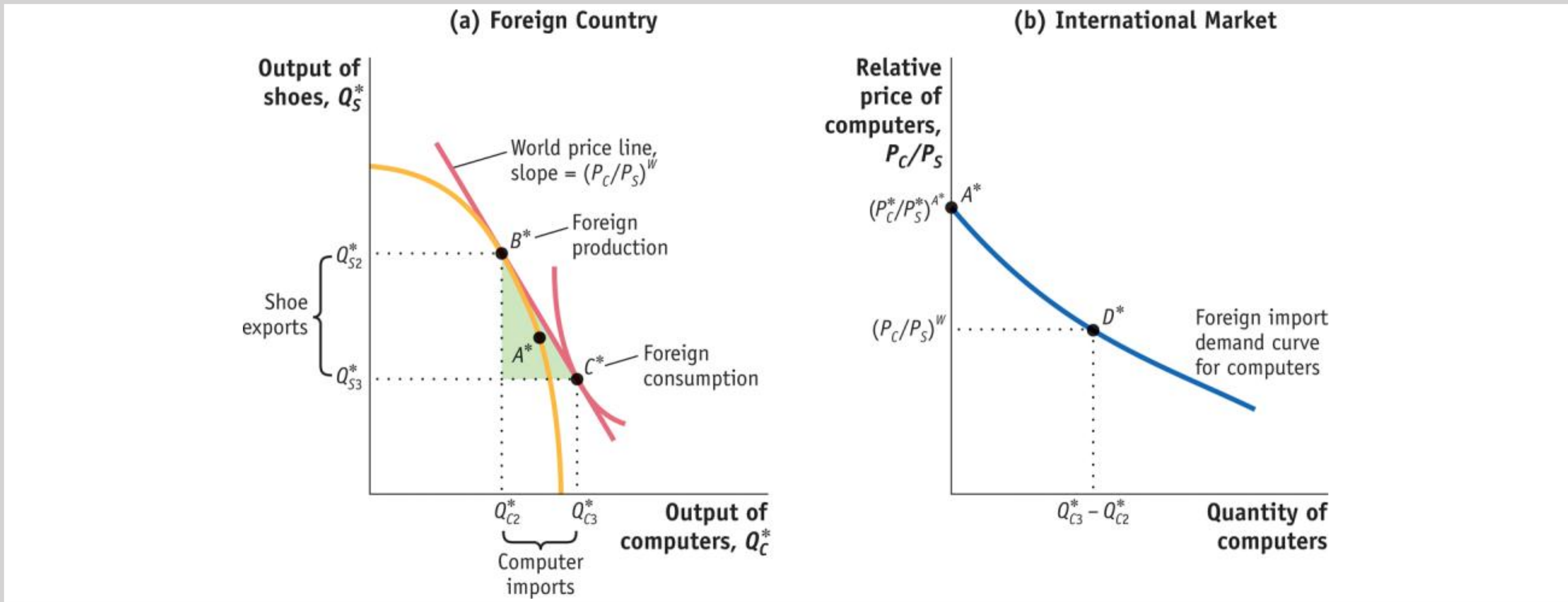
The "trade triangle" has a base equal to Foreign imports of computers (the difference between the consumption of computers and the amount produced with trade, $Q^*_{C3} - Q^*_{C2}$).

# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Foreign Equilibrium with Free Trade

FIGURE 4-4 (2 of 2) International Free-Trade Equilibrium in Foreign (continued)




The height of this triangle is Foreign exports of shoes (the difference between the production of shoes and the amount consumed with trade, $Q^*_{S2} - Q^*_{S3}$).

In panel (b), we show Foreign imports of computers equal to zero at the no-trade relative price, $(P^*_C / P^*_S)^{A^*}$, and equal to $(Q^*_{C3} - Q^*_{C2})$ at the free-trade relative price, $(P_C / P_S)^W$.

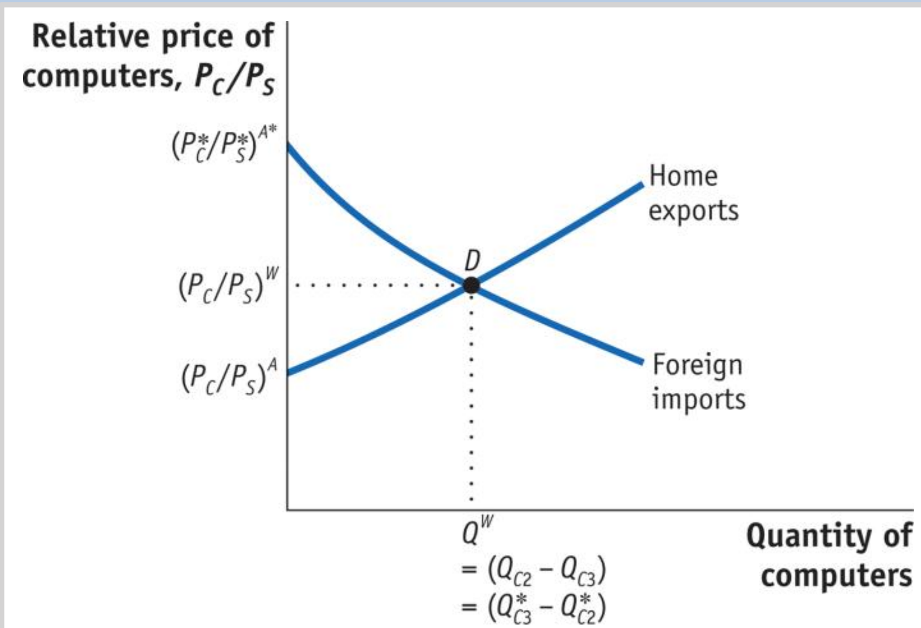
# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Equilibrium Price with Free Trade

Because exports equal imports, there is no reason for the relative price to change and so this is a **free-trade equilibrium**.

FIGURE 4-5 Determination of the Free-Trade World Equilibrium Price




The world relative price of computers in the free-trade equilibrium is determined at the intersection of the Home export supply and Foreign import demand, at point *D*.

At this relative price, the quantity of computers that Home wants to export, $(Q_{C2} - Q_{C3})$, just equals the quantity of computers that Foreign wants to import, $(Q^*_{C3} - Q^*_{C2})$.

# 1 Heckscher-Ohlin Model

## Free-Trade Equilibrium

### Pattern of Trade

- Home exports computers, the good that uses intensively the factor of production (capital) found in abundance at Home.

- Foreign exports shoes, the good that uses intensively the factor of production (labor) found in abundance there.

- This important result is called the **Heckscher-Ohlin theorem**.

# 1 Heckscher-Ohlin Model

## Heckscher-Ohlin Theorem

**Assumption 1:** Labor and capital flow freely between the industries.

**Assumption 2:** The production of shoes is labor-intensive as compared with computer production, which is capital-intensive.

**Assumption 3:** The amounts of labor and capital found in the two countries differ, with Foreign abundant in labor and Home abundant in capital.

**Assumption 4:** There is free international trade in goods.

**Assumption 5:** The technologies for producing shoes and computers are the same across countries.

**Assumption 6:** Tastes are the same across countries.

## 2 Testing the Heckscher-Ohlin Model

The first test of the Heckscher-Ohlin theorem was performed by economist Wassily Leontief in 1953.

- Leontief supposed correctly that in 1947 the United States was abundant in capital relative to the rest of the world.
- Thus, from the Heckscher-Ohlin theorem, Leontief expected that the United States would export capital-intensive goods and import labor-intensive goods.
- What Leontief actually found, however, was just the opposite: the capital–labor ratio for U.S. imports was *higher* than the capital–labor ratio found for U.S. exports.
- This finding contradicted the Heckscher-Ohlin theorem and came to be called **Leontief's paradox.**

## 2 Testing the Heckscher-Ohlin Model

### Leontief's Paradox

**TABLE 4-1** Leontief's Test

Leontief used the numbers in this table to test the Heckscher-Ohlin theorem. Each column shows the amount of capital or labor needed to produce $1 million worth of exports from, or imports into, the United States in 1947. As shown in the last row, the capital–labor ratio for exports was less than the capital–labor ratio for imports, which is a paradoxical finding.

| | Exports | Imports |
|---|---|---|
| Capital ($ millions) | 2.55 | 3.1 |
| Labor (person-years) | 182 | 170 |
| Capital/labor ($/person) | 14,000 | 18,200 |

# 2 Testing the Heckscher-Ohlin Model

## Leontief's Paradox

### Explanations

- U.S. and foreign technologies are not the same, in contrast to what the HO theorem and Leontief assumed.
- By focusing only on labor and capital, Leontief ignored land abundance in the United States.
- Leontief should have distinguished between skilled and unskilled labor (because it would not be surprising to find that U.S. exports are intensive in skilled labor).
- The data for 1947 may be unusual because World War II had ended just two years earlier.
- The United States was not engaged in completely free trade, as the Heckscher-Ohlin theorem assumes.

# 2 Testing the Heckscher-Ohlin Model

## Factor Endowments in 2010

To determine whether a country is abundant in a certain factor, we compare the country's share of that factor with its share of world GDP.

- If its share of a factor exceeds its share of world GDP, then we conclude that the country is **abundant in that factor**.

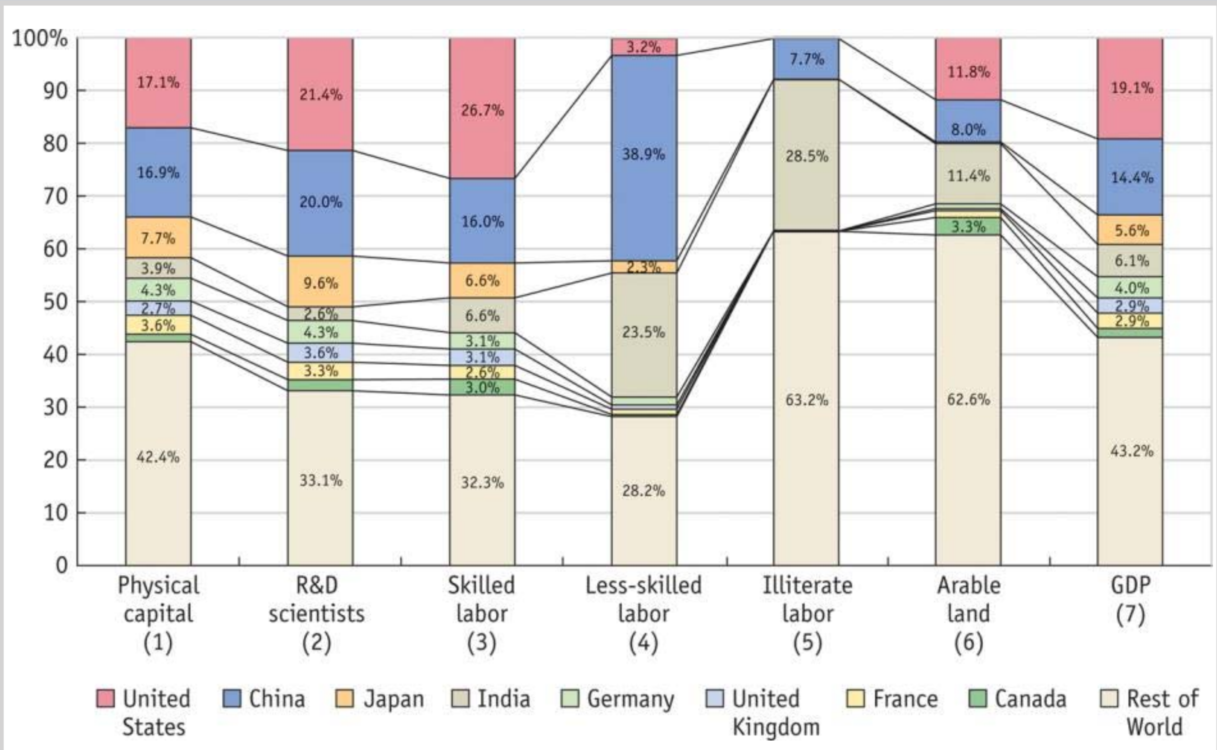
- If its share in a certain factor is less than its share of world GDP, then we conclude that the country is **scarce in that factor**.

# 2 Testing the Heckscher-Ohlin Model

## Factor Endowments in the New Millennium

### Capital, Labor and Land Abundance

FIGURE 4-6 Country Factor Endowments, 2010




Shown here are country shares of six factors of production in the year 2010, for eight countries and the rest of the world. We see that 17% of the world's physical capital was located in the United States, with 17% located in China, 8% located in Japan. In the final bar graph, we see the United States had 19% of world GDP, China had 14%, Japan had 5.6%, and so on.

# 2 Testing the Heckscher-Ohlin Model

## Differing Productivities Across Countries

In the original formulation of the paradox, Leontief had found that the United States was exporting labor-intensive products even though it was capital-abundant at that time.

- One explanation for this outcome would be that labor is highly productive in the United States and less productive in the rest of the world.

- If that is the case, then the **effective labor force** in the United States, the labor force times its productivity, is much larger than it appears to be when we just count people.

## 2 Testing the Heckscher-Ohlin Model

### Differing Productivities Across Countries

### Measuring Factor Abundance Once Again

To allow factors of production to differ in their productivities across countries, we define the **effective factor endowment** as the actual amount of a factor found in a country times its productivity.

$$\textit{Effective factor endowment} = \textit{Actual factor endowment} \bullet \textit{Factor productivity}$$

# 2 Testing the Heckscher-Ohlin Model

## Differing Productivities Across Countries

### Measuring Factor Abundance Once Again

To determine whether a country is abundant in a certain factor, we compare the country's share of that *effective* factor with its share of world GDP.

- If its share of an effective factor exceeds its share of world GDP, the country is **abundant in that effective factor**; if its share of an effective factor is less than its share of world GDP, the country is **scarce in that effective factor**.

### Effective R&D Scientists

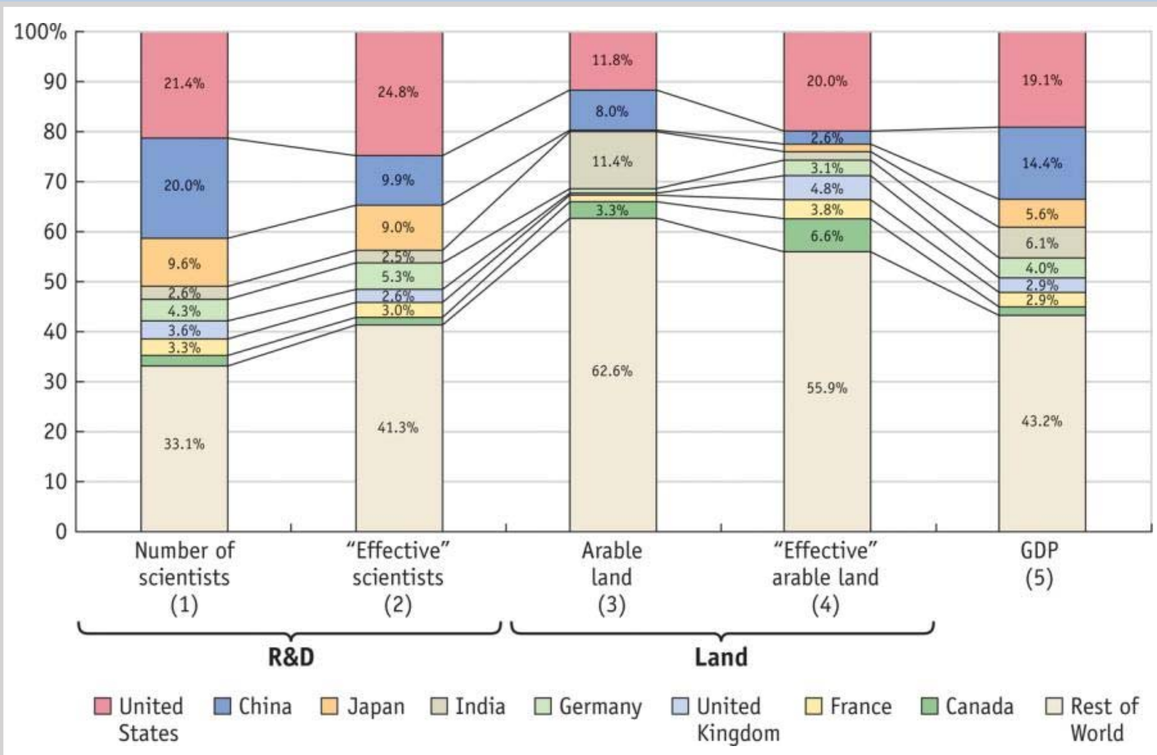
*Effective R&D scientists =*

*Actual R&D scientists • R&D spending per scientist*

# 2 Testing the Heckscher-Ohlin Model

## Differing Productivities Across Countries

FIGURE 4-7 (1 of 2) "Effective" Factor Endowments, 2010

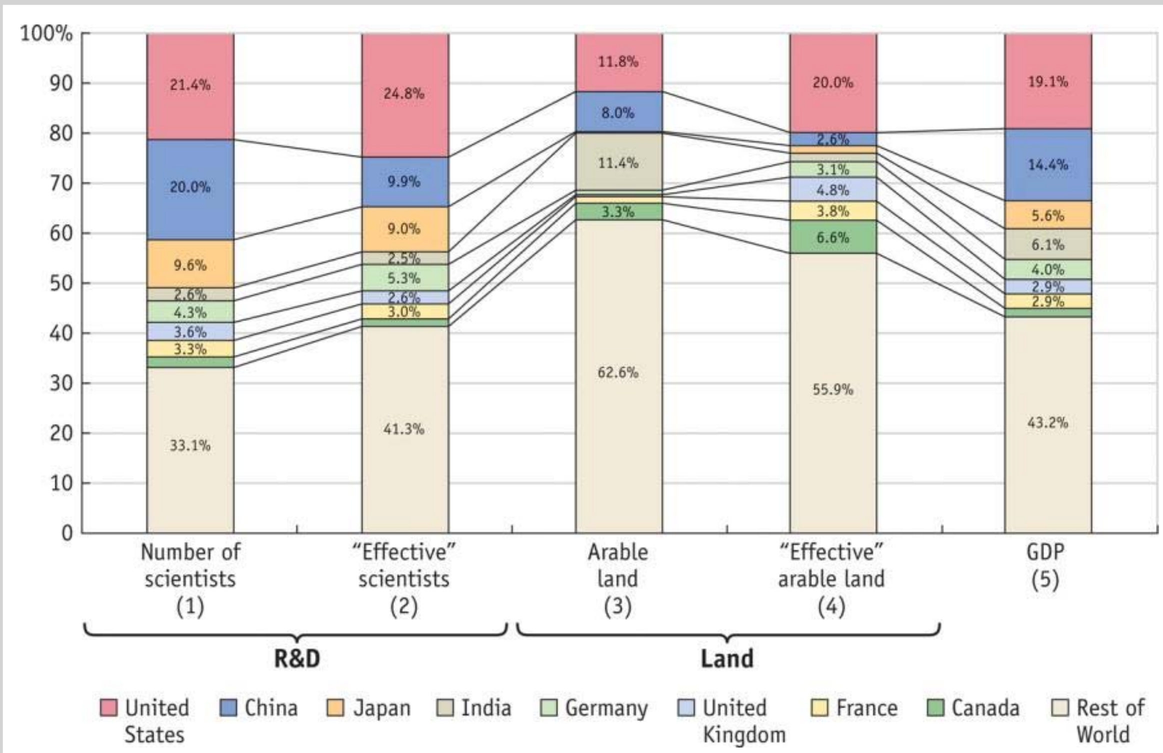



Shown here are country shares of R&D scientists and land in 2010, using the information from Figure 4.6, and adjusting for the productivity of each factor across countries to obtain the "effective" shares. China was abundant in R&D scientists (since it had 20% of the world's R&D scientists as compared with 14% of the world's GDP) but scarce in effective R&D scientists (having 7% of the world's effective R&D scientists as compared with 11% of the world's GDP).

## 2 Testing the Heckscher-Ohlin Model

### Differing Productivities Across Countries

FIGURE 4-7 (2 of 2) "Effective" Factor Endowments, 2010 (continued)



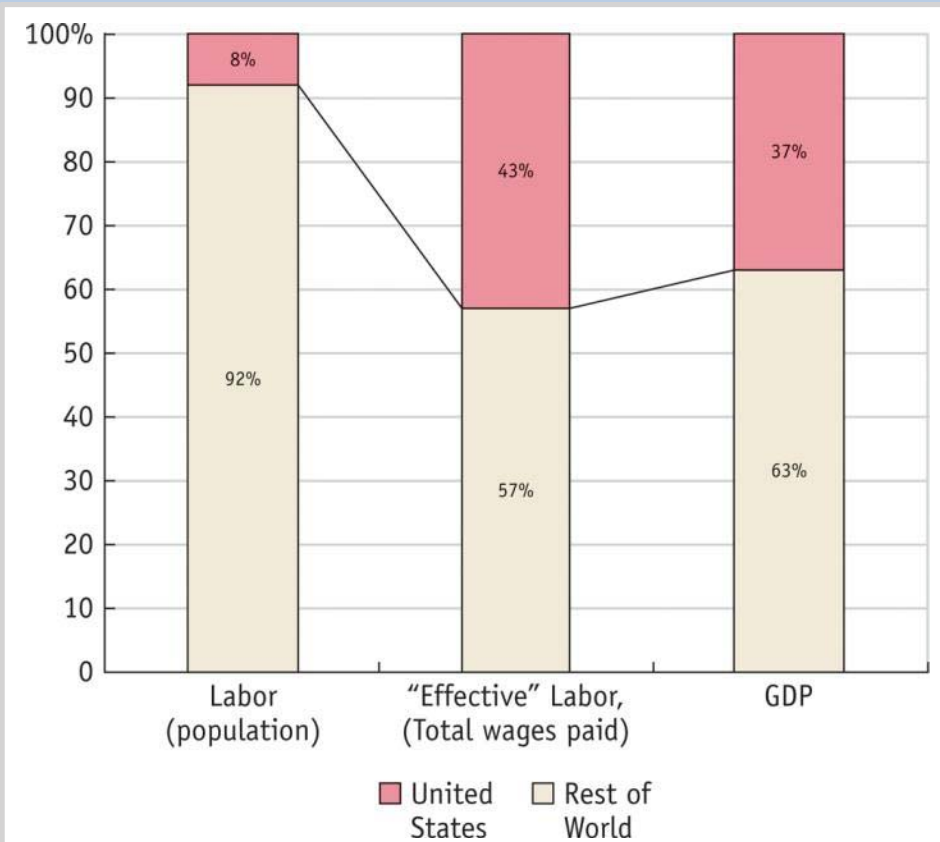

In 2010, the United States was scarce in arable land when using the number of acres (since it had 12% of the world's land as compared with 19% of the world's GDP) but neither scarce nor abundant in effective land (since it had 20% of the world's effective land, which nearly equaled its share of the world's GDP).

## 2 Testing the Heckscher-Ohlin Model

### Leontief's Paradox Once Again

### Labor Abundance

FIGURE 4-8 Labor Endowment and GDP for the United States and Rest of World, 1947



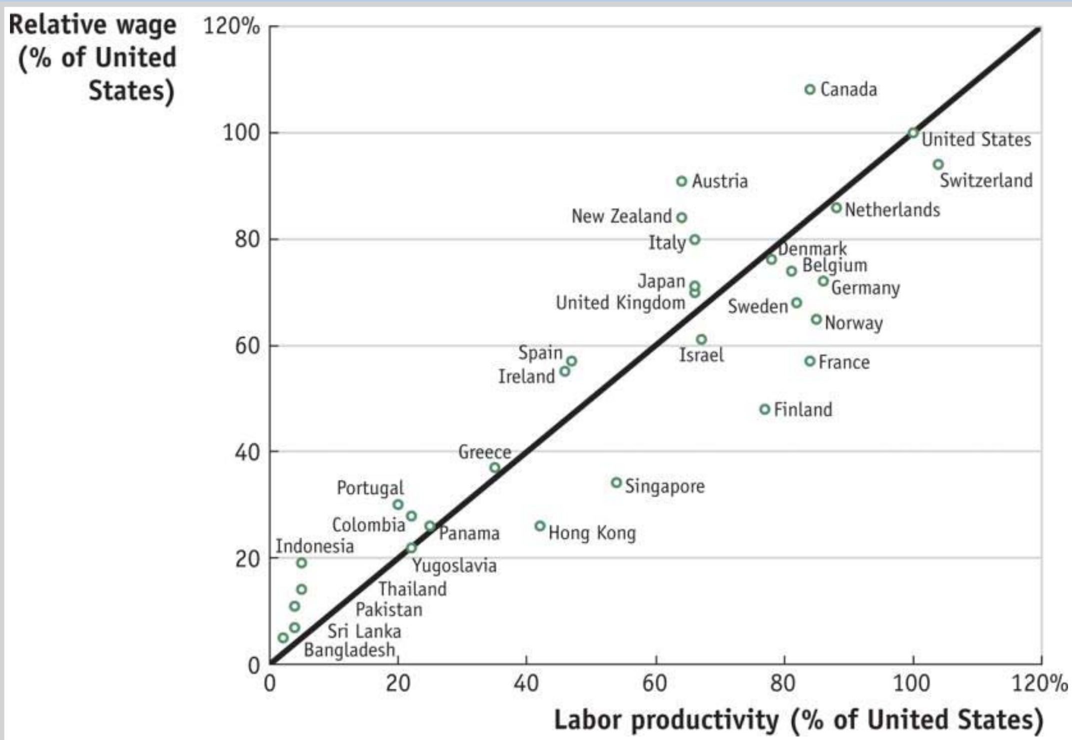

Shown here are the share of labor, "effective" labor, and GDP of the U.S. and the rest of the world in 1947. The U.S. had only 8% of the world's population, as compared to 37% of the world's GDP, so it was very scarce in labor. But when we measure effective labor by the total wages paid in each country, then the United States had 43% of the world's effective labor as compared to 37% of GDP, so it was abundant in effective labor.

## 2 Testing the Heckscher-Ohlin Model

### Leontief's Paradox Once Again

### Labor Productivity

FIGURE 4-9 Labor Productivity and Wages




Shown here are estimated labor productivities across countries, and their wages, relative to the United States in 1990.

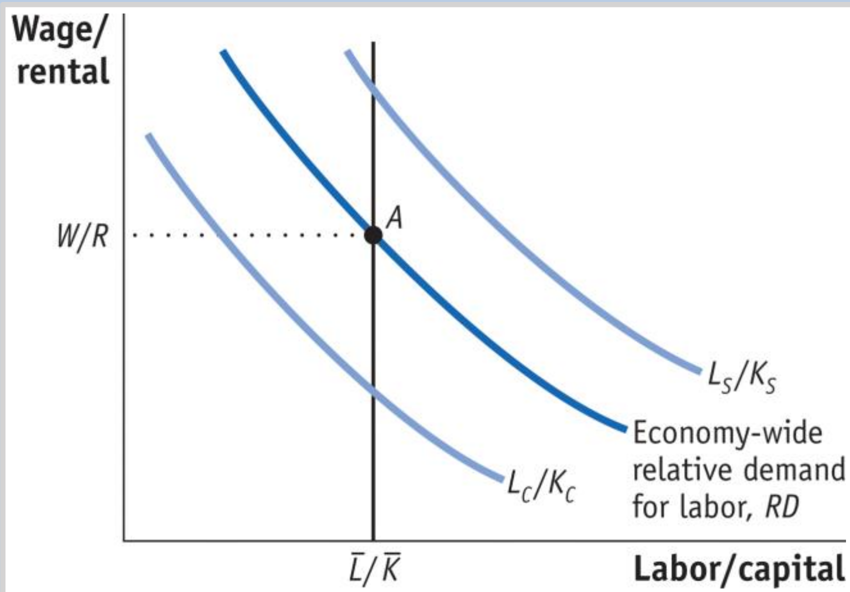
Notice that the labor and wages were highly correlated across countries: the points roughly line up along the 45-degree line.

## 3 Effects of Trade on Factor Prices

### Effect of Trade on the Wage and Rental of Home

#### Economy-Wide Relative Demand for Labor

FIGURE 4-10 Determination of Home Wage/Rental




$$\underbrace{\frac{\bar{L}}{\bar{K}}}_{\text{Relative supply}} = \frac{L_C + L_S}{\bar{K}} = \underbrace{\frac{L_C}{K_C} \cdot \left(\frac{K_C}{\bar{K}}\right) + \frac{L_S}{K_S}\left(\frac{K_S}{\bar{K}}\right)}_{\text{Relative demand}}$$

The economy-wide relative demand for labor, *RD*, is an average of the $L_C/K_C$ and $L_S/K_S$ curves and lies between these curves.

The relative supply, $\bar{L}/\bar{K}$, is shown by a vertical line because the total amount of resources in Home is fixed.

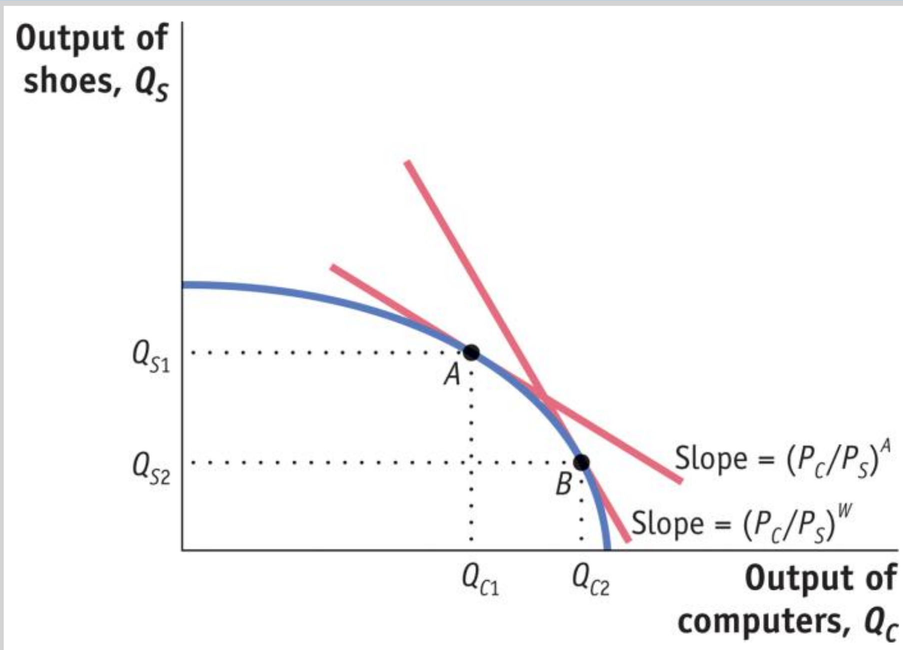
The equilibrium point *A*, at which relative demand *RD* intersects relative supply $\bar{L}/\bar{K}$, determines the wage relative to the rental, *W*/*R*.

# 3 Effects of Trade on Factor Prices

## Effect of Trade on the Wage and Rental of Home

### Increase in the Relative Price of Computers

FIGURE 4-11 Increase in the Price of Computers




Initially, Home is at a no-trade equilibrium at point *A* with a relative price of computers of $(P_C/P_S)^A$.

An increase in the relative price of computers to the world price, as illustrated by the steeper world price line, $(P_C/P_S)^W$, shifts production from point *A* to *B*.

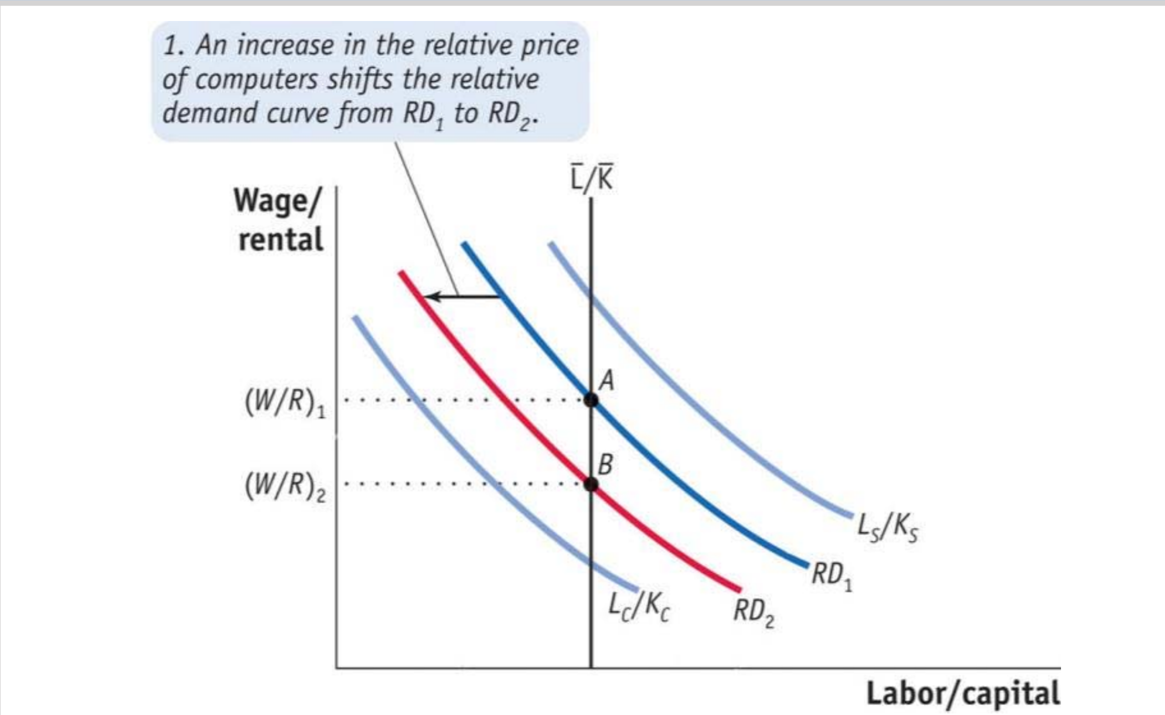
At point *B*, there is a higher output of computers and a lower output of shoes, $Q_{C2} > Q_{C1}$ and $Q_{S2} < Q_{S1}$.

# 3 Effects of Trade on Factor Prices

## Effect of Trade on the Wage and Rental of Home

### Increase in the Relative Price of Computers

FIGURE 4-12 (1 of 2) Effect of a Higher Relative Price of Computers on Wage/Rental



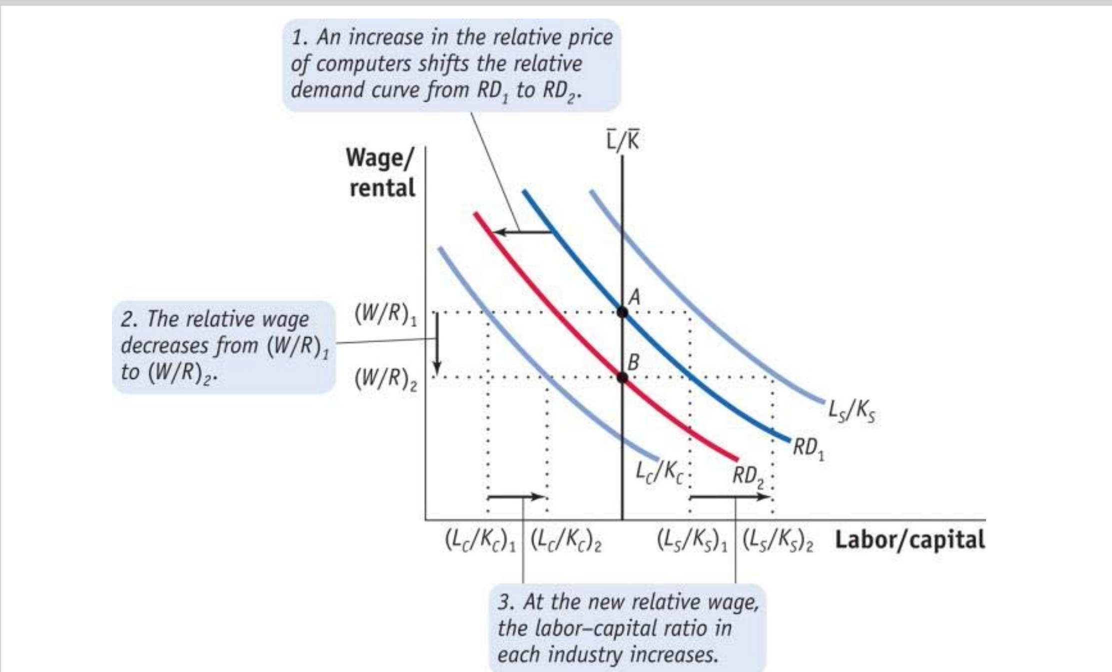

An increase in the relative price of computers shifts the economy-wide relative demand for labor, $RD_1$, toward the relative demand for labor in the computer industry, $L_C/K_C$. The new relative demand curve, $RD_2$, intersects the relative supply curve for labor at a lower relative wage, $(W/R)_2$.

# 3 Effects of Trade on Factor Prices

## Effect of Trade on the Wage and Rental of Home

### Increase in the Relative Price of Computers

FIGURE 4-12 (2 of 2) Effect of a Higher Relative Price of Computers on Wage/Rental




As a result, the wage relative to the rental falls from $(W/R)_1$ to $(W/R)_2$.

The lower relative wage causes both industries to increase their labor–capital ratios, as illustrated by the increase in both $L_C/K_C$ and $L_S/K_S$ at the new relative wage.

$$\underbrace{\frac{\bar{L}}{\bar{K}}}_{\substack{\text{Relative supply} \\ \text{No change}}} = \underbrace{\underset{\uparrow}{\frac{L_C}{K_C}} \cdot \underset{\uparrow}{\left(\frac{K_C}{\bar{K}}\right)} + \underset{\uparrow}{\frac{L_S}{K_S}} \cdot \underset{\downarrow}{\left(\frac{K_S}{\bar{K}}\right)}}_{\substack{\text{Relative demand} \\ \text{No change in total}}}$$

## 3 Effects of Trade on Factor Prices

### Determination of the Real Wage and Real Rental

#### Change in the Real Rental

$$R = P_C \bullet MPK_C \text{ and } R = P_S \bullet MPK_S$$

$$MPK_C = R/P_C \uparrow \text{ and } MPK_S = R/P_S \uparrow$$

#### Change in the Real Wage

$$W = P_C \bullet MPL_C \text{ and } W = P_S \bullet MPL_S$$

$$MPL_C = W/P_C \downarrow \text{ and } MPL_S = W/P_S \downarrow$$

# 3 Effects of Trade on Factor Prices

## Determination of the Real Wage and Real Rental

### Stolper-Samuelson Theorem

- In the long run, when all factors are mobile, an increase in the relative price of a good will increase the real earnings of the factor used intensively in the production of that good and decrease the real earnings of the other factor.

- For our example, the **Stolper-Samuelson theorem** predicts that when Home opens to trade and faces a higher relative price of computers, the real rental on capital in Home rises and the real wage in Home falls. In Foreign, the changes in real factor prices are just the reverse.

## 3 Effects of Trade on Factor Prices

### Changes in the Real Wage and Rental: A Numerical Example

To illustrate the Stolper-Samuelson theorem, we use a numerical example to show how much the real wage and rental can change in response to a change in price.

*Computers:*

Sales revenue = $PC \bullet QC = 100$

Earnings of labor = $W \bullet LC = 50$

Earnings of capital = $R \bullet KC = 50$

*Shoes:*

Sales revenue = $PS \bullet QS = 100$

Earnings of labor = $W \bullet LS = 60$

Earnings of capital = $R \bullet KS = 40$

## 3 Effects of Trade on Factor Prices

### Changes in the Real Wage and Rental: A Numerical Example

Notice that shoes are more labor-intensive than computers:

- the share of total revenue paid to labor in shoes is 60/100 = 60% and
- more than that share in computers is 50/100 = 50%.

When Home and Foreign undertake trade, the relative price of computers rises in Home. For simplicity:

*Computers:* Percentage increase in price = $\Delta P_C / P_C = 10\%$

*Shoes:* Percentage increase in price = $\Delta P_S / P_S = 0\%$

## 3 Effects of Trade on Factor Prices

### Changes in the Real Wage and Rental: A Numerical Example

- The rental on capital can be calculated by taking total sales revenue in each industry, subtracting the payments to labor, and dividing by the amount of capital.
- This calculation gives us the following formulas for the rental in each industry:

$$R = \frac{P_C \cdot Q_C - W \cdot L_C}{K_C}, \text{ for computers}$$

$$R = \frac{P_S \cdot Q_S - W \cdot L_S}{K_S}, \text{ for shoes}$$

## 3 Effects of Trade on Factor Prices

### Changes in the Real Wage and Rental: A Numerical Example

- The price of computers has risen, so $\Delta P_C > 0$, holding fixed the price of shoes, $\Delta P_S = 0$.
- We can trace through how this affects the rental by changing $P_C$ and $W$ in the previous two equations:

$$\Delta R = \frac{\Delta P_C \cdot Q_C - \Delta W \cdot L_C}{K_C}, \text{ for computers}$$

$$\Delta R = \frac{0 \cdot Q_C - \Delta W \cdot L_S}{K_S}, \text{ for shoes}$$

# 3 Effects of Trade on Factor Prices

## Changes in the Real Wage and Rental: A Numerical Example

- It is convenient to work with percentage changes in the variables. We can introduce these terms into the preceding formulas by rewriting them as:

$$\frac{\Delta R}{R} = \left(\frac{\Delta P_C}{P_C}\right)\left(\frac{P_C \cdot Q_C}{R \cdot K_C}\right) - \left(\frac{\Delta W}{W}\right)\left(\frac{W \cdot L_C}{R \cdot K_C}\right), \text{ for computers}$$

$$\frac{\Delta R}{R} = -\left(\frac{\Delta W}{W}\right)\left(\frac{W \cdot L_S}{R \cdot K_S}\right), \text{ for shoes}$$

- Plug the above data for shoes and computers into these formulas:

$$\frac{\Delta R}{R} = 10\% \cdot \left(\frac{100}{50}\right) - \left(\frac{\Delta W}{W}\right)\left(\frac{50}{50}\right), \text{ for computers}$$

$$\frac{\Delta R}{R} = -\left(\frac{\Delta W}{W}\right)\left(\frac{60}{40}\right), \text{ for shoes}$$

## Changes in the Real Wage and Rental: A Numerical Example

- Subtracting one equation from the other we get

$$\frac{\Delta R}{R} = 10\% \cdot \left(\frac{100}{50}\right) - \left(\frac{\Delta W}{W}\right)\left(\frac{50}{50}\right), \text{ for computers}$$

$$\text{Minus:} \quad \frac{\Delta R}{R} = 0 - \left(\frac{\Delta W}{W}\right)\left(\frac{60}{40}\right), \text{ for shoes}$$

$$\text{Equals:} \quad 0 = 10\% \cdot \left(\frac{100}{50}\right) + \left(\frac{\Delta W}{W}\right)\left(\frac{20}{40}\right)$$

## 3 Effects of Trade on Factor Prices

### Changes in the Real Wage and Rental: A Numerical Example

- Simplifying the last line, we get $0 = 20\% + \left(\frac{\Delta W}{W}\right)\left(\frac{1}{2}\right)$

$$\left(\frac{\Delta W}{W}\right) = \left(\frac{-20\%}{\frac{1}{2}}\right) = -40\%, \text{ is the change in wages}$$

- To find the change in the rental paid to capital ($\Delta R/R$), we can take our solution for $\Delta W/W = -40\%$, and plug it into the equation for the change in the rental in the shoes sector.

$$\frac{\Delta R}{R} = -\left(\frac{\Delta W}{W}\right)\left(\frac{60}{40}\right) = 40\% \cdot \left(\frac{60}{40}\right) = 60\%, \text{ change in rental}$$

# 3 Effects of Trade on Factor Prices

## Changes in the Real Wage and Rental: A Numerical Example

### General Equation for the Long-Run Change in Factor Prices

The long-run results of a change in factor prices can be summarized in the following equation:

$$\underbrace{\Delta W/W < 0}_{\text{Real wage falls}} < \underbrace{\Delta P_C/P_C < \Delta R/R}_{\text{Real rental increases}}, \text{ for an increase in } P_C$$

The relationship between the changes in product prices to changes in factor prices are called the "magnification effect" because it shows how changes in the prices of goods have a *magnified effect* on the earnings of factors.

$$\underbrace{\Delta R/R < \Delta P_C/P_C}_{\text{Real rental falls}} < \underbrace{0 < \Delta W/W}_{\text{Real wage increases}}, \text{ for an decrease in } P_C$$

$$\underbrace{\Delta R/R < 0}_{\text{Real rental falls}} < \underbrace{\Delta P_S/P_S < \Delta W/W}_{\text{Real wage increases}}, \text{ for an increase in } P_S$$