Introduction

In the specific-factors model:

- Aggregate gains from trade, as in Ricardo
- Some factors are specific to a sector
- Those who lose the most are those who are trapped in the comparative-disadvantage sector.

Introduction

Limits of the **specific-factors model?**

Things to keep:

- Different factors of production
- Sectors use factors in different proportions

Things to change:

- Mobility of each factor across sectors

Q: What happens to each factor when they are mobile across sectors?

Introduction

CHAPTER 4: Heckscher-Ohlin model

- Two factors of production, K and L, that are mobile across sectors
- *But sectors use K and L in different proportions.*
- Other assumptions remain the same:
  - Perfect competition
  - Constant returns to scale
  - Common prices under free trade

Introduction

CHAPTER 4: Heckscher-Ohlin model

Raises several questions:

- What determines trade flows in this model?
- Are there aggregate gains from trade?
- Who gains the most from trade?
- Who gains the least from trade?
- How do gains/losses relate to world prices?

Introduction

Interpretations

Short-run vs. long-run:

- Short-run: factors are stuck: use specific factor model
- Long-run: factors can adjust: → HO model

About capital and labor?

- We can use “skilled labor” instead of K
- We can use “unskilled labor” instead of L

Introduction

Interpretations

Short-run vs. long-run:

- Short-run: factors are stuck: use specific factor model
- Long-run: factors can adjust: → HO model

About capital and labor?

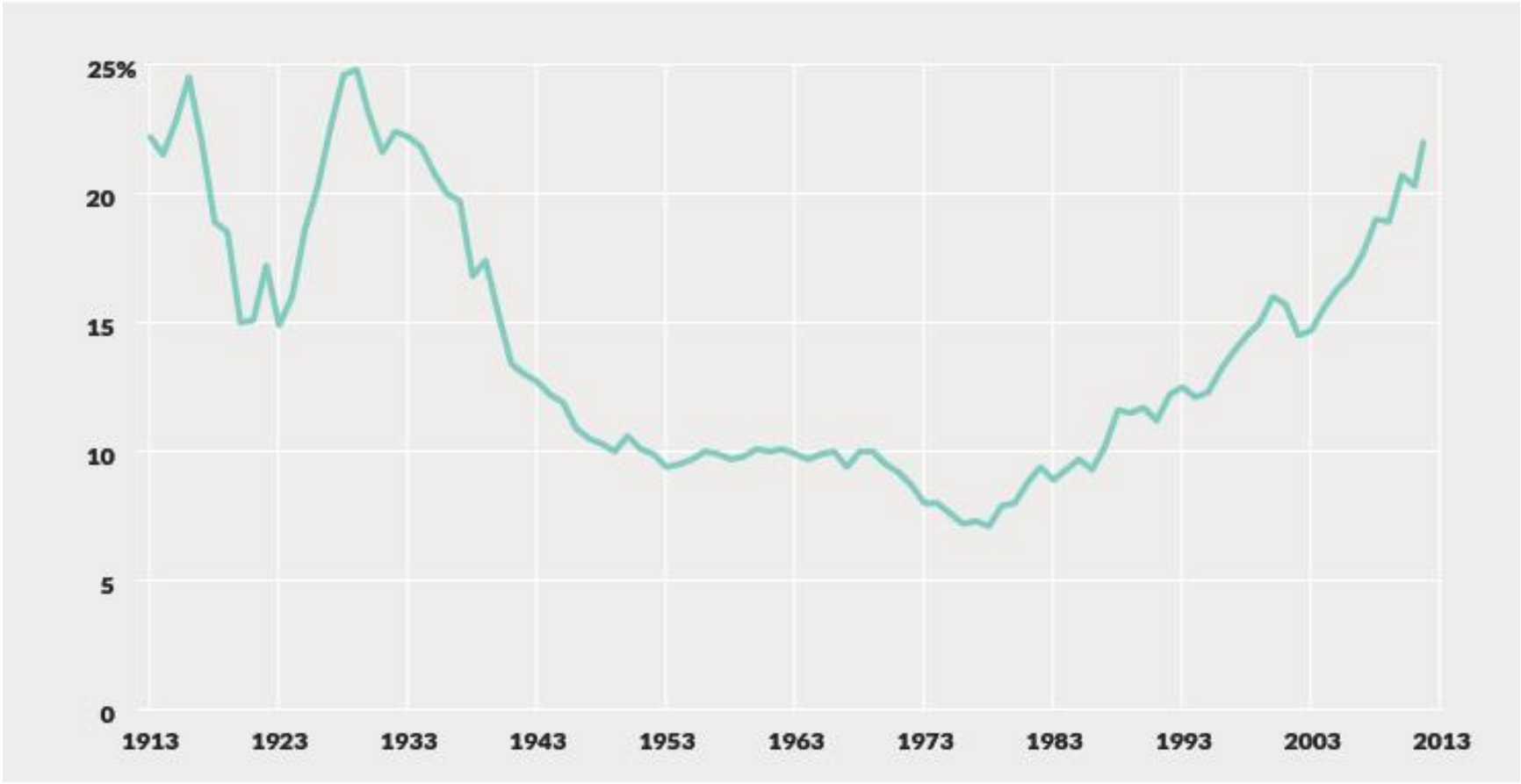
- We can use “skilled labor” instead of K
- We can use “unskilled labor” instead of L

Hence we can use the model to talk about **inequality in the long term:** Payments to K vs. L can be reinterpreted as payments to skilled vs. unskilled labor

Top-income inequality in the US

The Return of the Roaring Twenties

The share of total U.S. wealth owned by the top 0.1 percent of families, 1913-2012



Notes: Wealth is total assets (including real estate and funded pension wealth) net of all debts. Wealth excludes the present value of future government transfers (such as Social Security or Medicare benefits).

Source: Saez, Emmanuel and Gabriel Zucman "Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data", NBER Working Paper, October 2014, online at http://gabriel-zucman.eu/uswealth/

Washington Center for Equitable Growth

Introduction

Plan of lecture on Heckscher-Ohlin model (ch 4):

- Introduction
- Model: who trade what?
- Trade and factors of production in data
- Payments to K and L

Heckscher-Ohlin Model

Assumptions of the Heckscher-Ohlin Model

Assumption 1: Two factors of production, L and K, can move freely between the industries.

Assumption 2: Two sectors: Shoes" and Computers production of shoes is "labor-intensive".

Heckscher-Ohlin Model

Some definitions:

Definition: We say that shoe production is "labor-intensive" if it requires more labor per unit of capital to produce shoes than computers, so that $L_S / K_S > L_C / K_C$.

Wage: payment to Labor

Rental rate: payment to K

What determines the use of K vs. L in a sector?

Heckscher-Ohlin Model

Some definitions:

Definition: We say that shoe production is "labor-intensive" if it requires more labor per unit of capital to produce shoes than computers, so that $L_S / K_S > L_C / K_C$.

Wage: payment to Labor

Rental rate: payment to K

What determines the use of K vs. L in a sector?

Ratio of rental rate / wage:

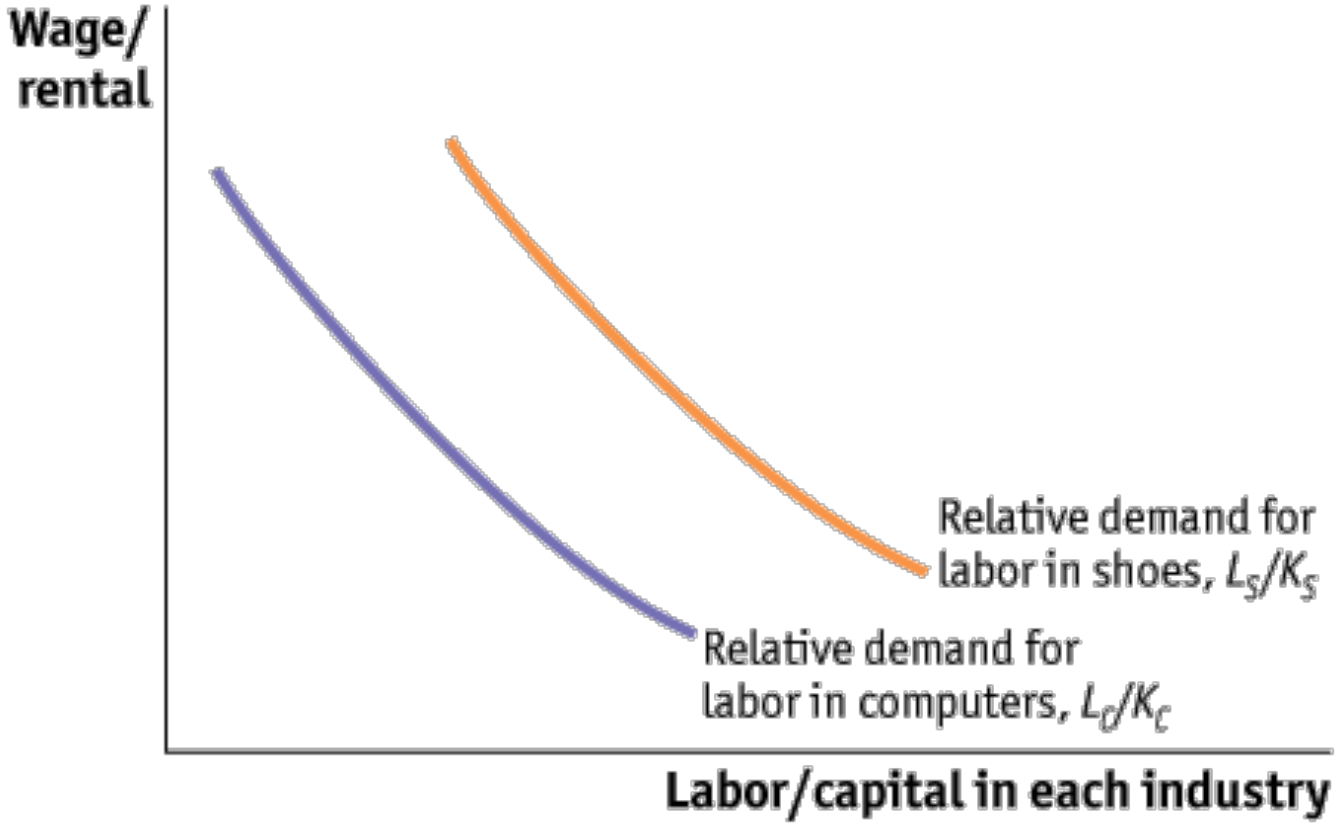
Higher relative price of K ➔ More intensive use of L vs. K

Heckscher-Ohlin Model

Labor Intensity of Each Industry

The demand for labor relative to capital is assumed to be higher in shoes than in computers: $L_S/K_S > L_C/K_C$.

Assumption 2: ***the two curves never intersect***



Heckscher-Ohlin Model

Optimal use of L and K in the Shoe industry?

- At optimum:

  $w = P_S \,.\, MPL_S$ and $r = P_S \,.\, MPK_S$

- This implies:

  $w / r = MPL_S / MPK_S$

  where MPL_S / MPK_S depends primarily on K_S / L_S

  This provides a relationship between K_S / L_S and w/r (like the one provided in the previous graph)

Heckscher-Ohlin Model

Examples of production functions:

- Shoe: $Y_S = a_S L_S^{1-\alpha} K_S^{\alpha}$ with $\alpha > 0$

Optimal use of L and K in the Shoe industry:

- MPL in Shoes: $MPL_S = (1-\alpha)\, a_S \left(K_S / L_S\right)^{\alpha}$
- MPK in Shoes: $MPK_S = \alpha\, a_S \left(L_S / K_S\right)^{1-\alpha}$
- $w = P_S \,.\, MPL_S$ and $r = P_S \,.\, MPK_S$ implies:

$$\frac{r}{w} = \frac{MPK_S}{MPL_S} = \frac{\alpha}{1-\alpha}\frac{L_S}{K_S} \quad \Rightarrow \quad \frac{K_S}{L_S} = \frac{\alpha}{1-\alpha}\left(\frac{r}{w}\right)^{-1}$$

Heckscher-Ohlin Model

Examples of production functions:

- Computer: $Y_C = a_C L_C^{1-\beta} K_C^{\beta}$ with $\beta > \alpha$

Optimal use of L and K in the Computer industry:

- MPK in Computers: $MPK_C = \beta\, a_C \left(L_C / K_C\right)^{1-\beta}$

- $w = P_C \,.\, MPL_C$ and $r = P_C \,.\, MPK_C$ implies:

$$\frac{r}{w} = \frac{MPK_C}{MPL_C} = \frac{\beta}{1-\beta}\frac{L_C}{K_C}$$

- $\beta > \alpha \quad \Rightarrow \quad \frac{K_C}{L_C} = \frac{\beta}{1-\beta}\left(\frac{r}{w}\right)^{-1} > \frac{K_S}{L_S}$ for all r/w

Heckscher-Ohlin Model

Other assumptions of the Heckscher-Ohlin Model

Assumption 3: Foreign is "Labor abundant", Home is Capital abundant.

Notation: $\bar{K}$ and $\bar{L}$: supply of K and L in Home country

$\bar{K}^*$ and $\bar{L}^*$: supply of K and L in Foreign country

Definition: Foreign is "labor-abundant" means that the labor-capital ratio in Foreign exceeds that in Home:

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

Assumption 4: Goods can be traded freely, but labor and capital do not move between countries.

Heckscher-Ohlin Model

Other assumptions of the Heckscher-Ohlin Model

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.

Heckscher-Ohlin Model

Production functions:

- Shoe: $Y_S = a_S L_S^{1-\alpha} K_S^{\alpha}$
- Computer: $Y_C = a_C L_C^{1-\beta} K_C^{\beta}$ $\qquad \beta > \alpha$

→ Production possibility frontier for Home?

Heckscher-Ohlin Model

Production functions:

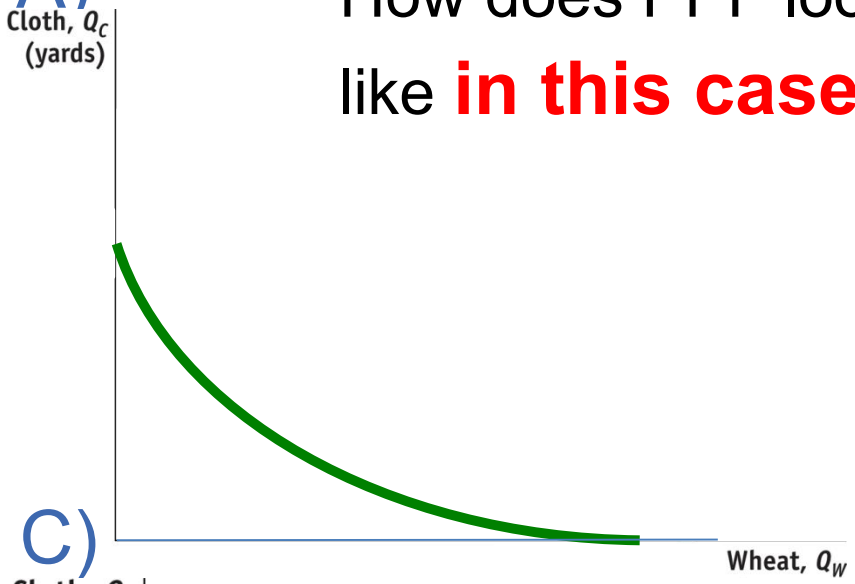
- Shoe: $Y_S = a_S L_S^{1-\alpha} K_S^{\alpha}$
- Computer: $Y_C = a_C L_C^{1-\beta} K_C^{\beta}$ $\beta > \alpha$
- Resource constraints:

$K_C + K_S = \overline{K}$ and $L_C + L_S = \overline{L}$

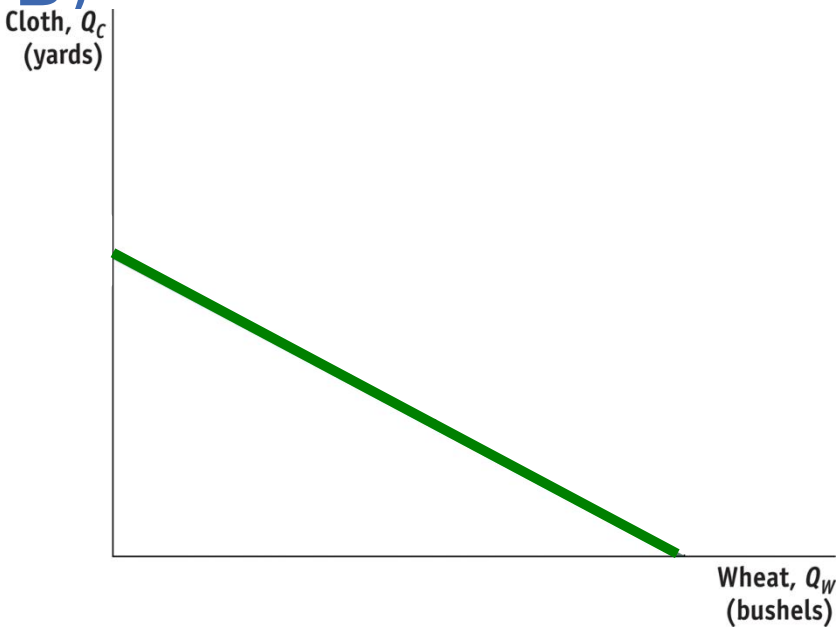
→ Production possibility frontier for Home?

How does PPF look like **in this case?**

A)

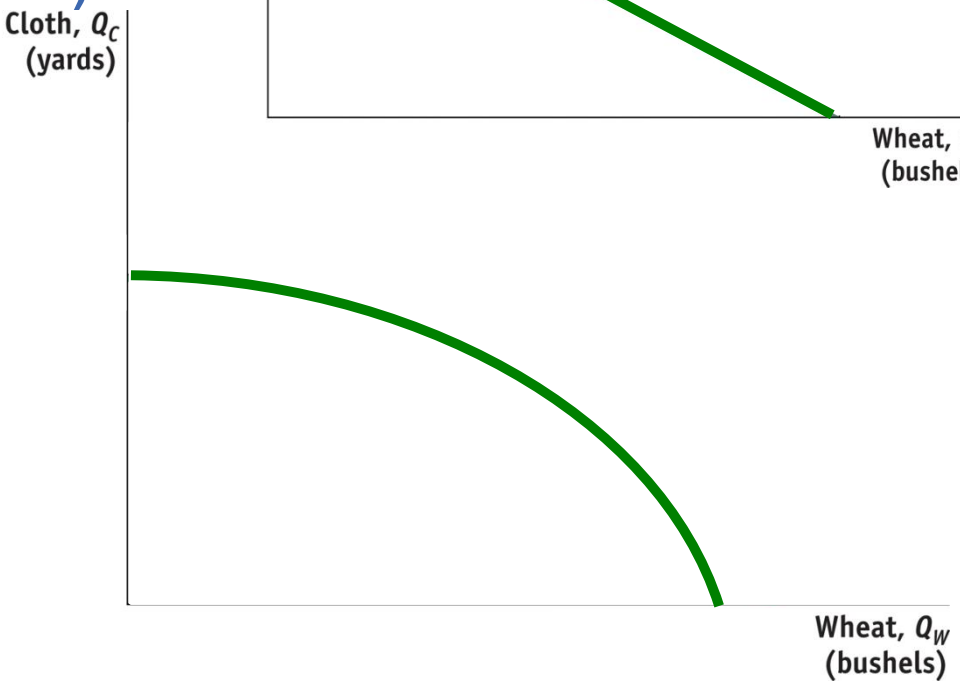


B)



C)

D)



Heckscher-Ohlin Model

Same production functions for Foreign:

- Shoe: $Y'_S = a_S L'_S{}^{\alpha} K'_S{}^{1-\alpha}$
- Computer: $Y'_C = a_C L'_C{}^{1-\beta} K'_C{}^{\beta}$

- Resource constraints:

$K'_C + K'_S = \overline{K}^*$ and $L'_C + L'_S = \overline{L}^*$

→ Production possibility frontier for Foreign?

→ How does it compare to Home?

Heckscher-Ohlin Model

Same production functions for Foreign:

- Shoe: $Y'_S = a_S L'_S{}^{\alpha} K'_S{}^{1-\alpha}$
- Computer: $Y'_C = a_C L'_C{}^{1-\beta} K'_C{}^{\beta}$

- Resource constraints:

$K'_C + K'_S = \overline{K}^*$ and $L'_C + L'_S = \overline{L}^*$

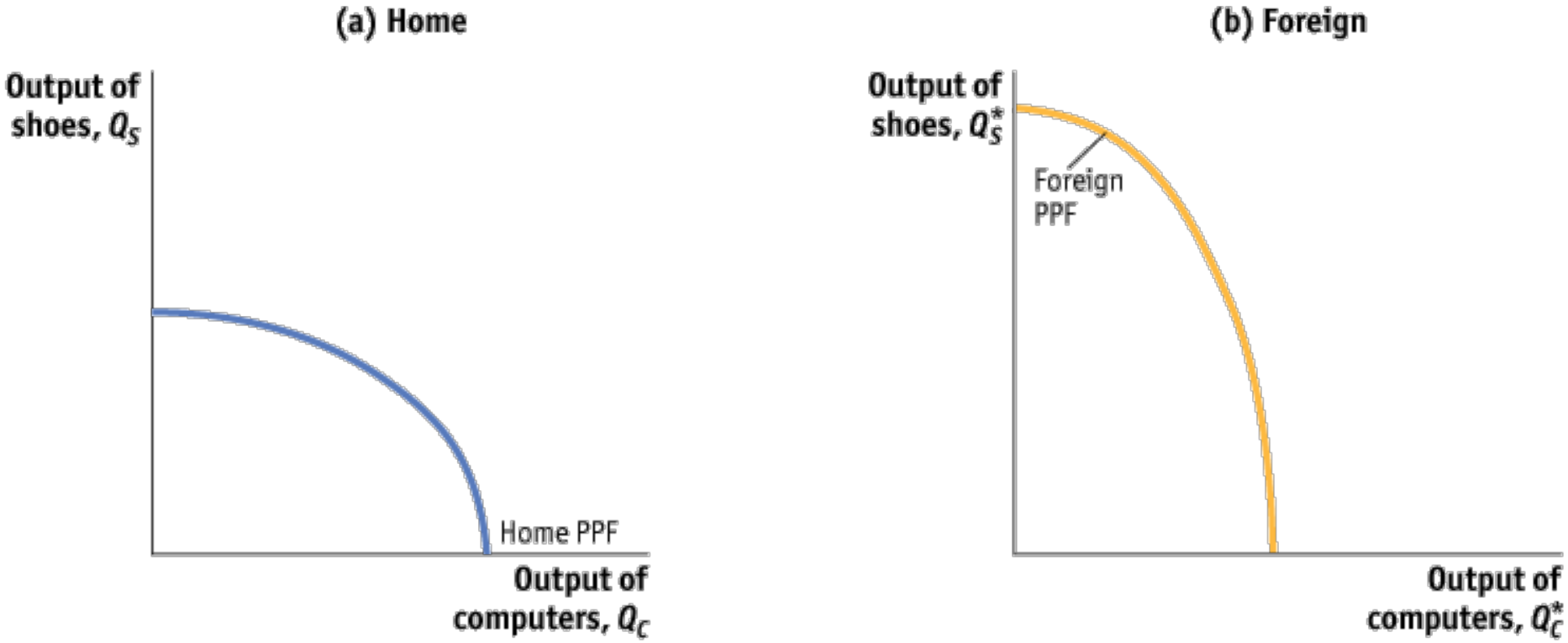
→ Production possibility frontier for Foreign?

Reminder: Home is K-abundant: $\overline{K}/\overline{L} > \overline{K}^*/\overline{L}^*$

No-Trade Equilibrium

PPF, Indifference Curves, and Autarky Price

Autarky Equilibria in Home and Foreign



Home vs Foreign PPF:

Because Home is **capital abundant**, the Home PPF is skewed toward computers.

Heckscher-Ohlin Model

Is the slope of the PPF equal to…?

a) MPK_S/MPK_C

b) MPL_S/MPL_C

c) Both: slope = $MPK_S/MPK_C = MPL_S/MPL_C$

d) slope = $MPL_S/MPL_C + MPK_S/MPK_C$

e) None of the above

Heckscher-Ohlin Model

Answer:

Note also: slope = relative price P_C/P_S

Heckscher-Ohlin Model

Labor market equilibrium:

$$W = P_S \cdot MPL_S$$
$$W = P_C \cdot MPL_C$$
$$\Rightarrow \frac{P_C}{P_S} = \frac{MPL_S}{MPL_C}$$

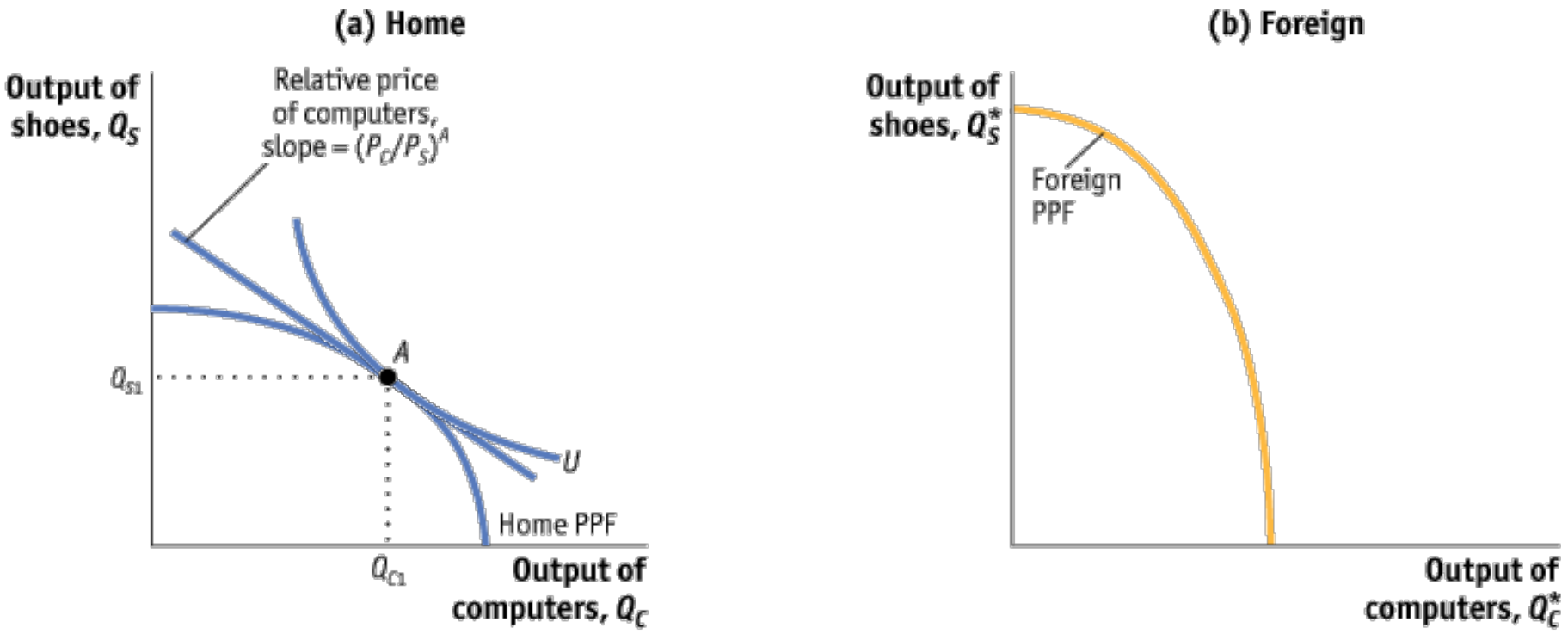
Capital market equilibrium:

$$R = P_S \cdot MPK_S$$
$$R = P_C \cdot MPK_C$$
$$\Rightarrow \frac{P_C}{P_S} = \frac{MPK_S}{MPK_C}$$

No-Trade Equilibrium

PPF, Indifference Curves, and Autarky Price

Autarky Equilibria in Home and Foreign (continued)

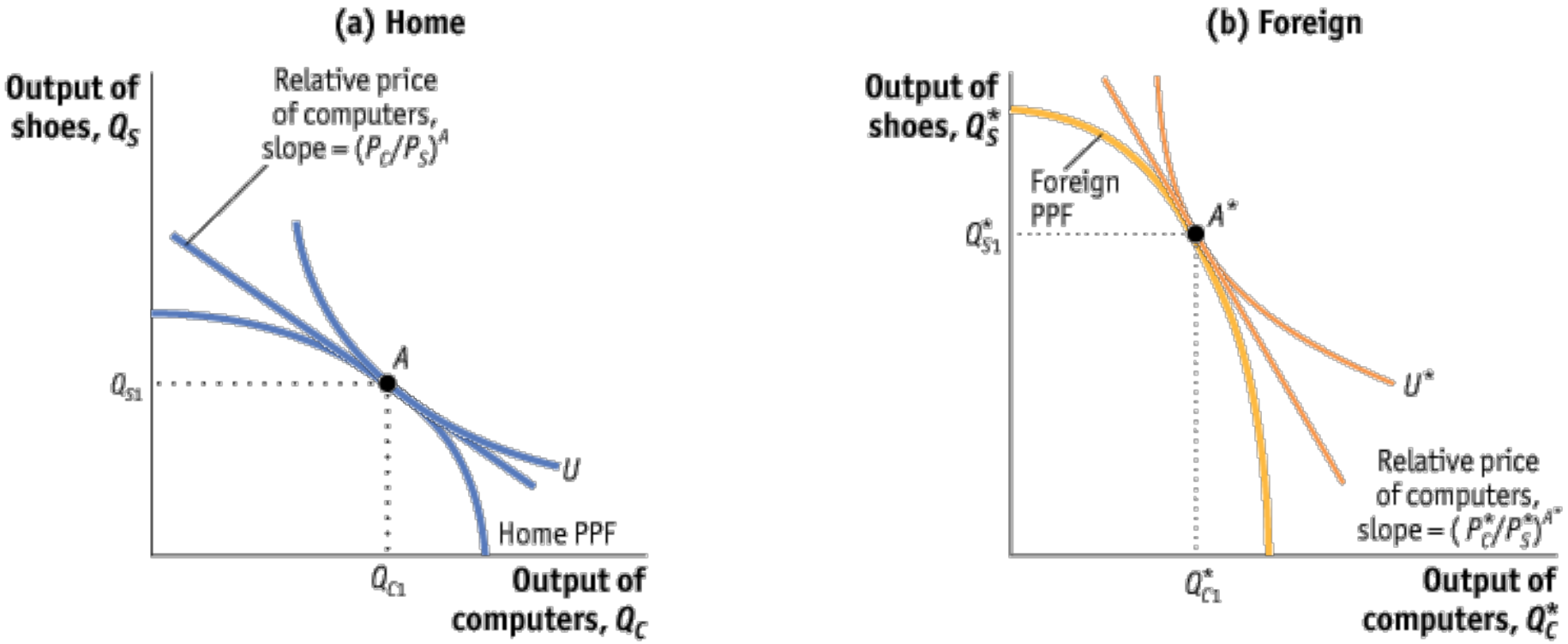


The flat slope indicates a low relative price of computers at Home in Autarky: $(P_C/P_S)^A$

No-Trade Equilibrium

PPF, Indifference Curves, and Autarky Price

Autarky Equilibria in Home and Foreign (continued)



The Foreign Autarky equilibrium has higher relative price of computers, as indicated by the steeper slope of $(P^*_C/P^*_S)^{A*}$

Heckscher-Ohlin Model

Relative price with free trade:

In autarky: $(P_C / P_S)^A < (P^*_C / P^*_S)^{A^*}$

Home has a "comparative advantage" in computers

With trade: $(P_C / P_S)^W$ such that:

$(P_C / P_S)^A < (P_C / P_S)^W < (P^*_C / P^*_S)^{A^*}$

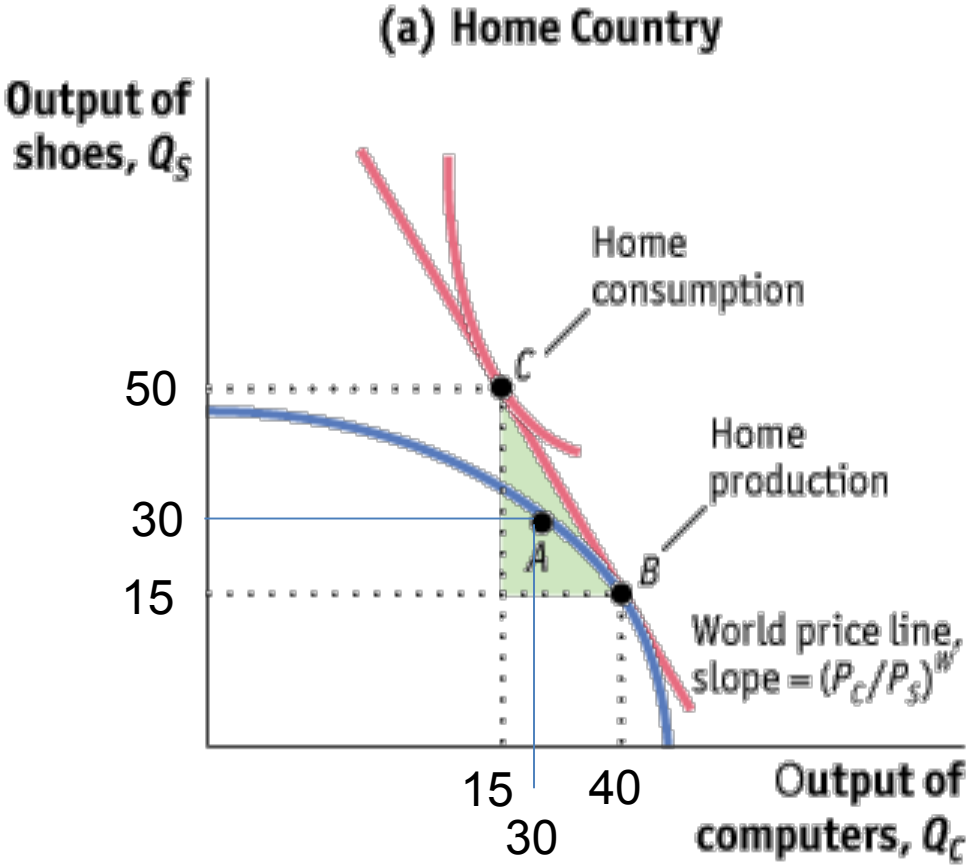
Heckscher-Ohlin Model

Relative price with free trade:

- Home export supply curve of computers?
- Foreign import demand curve of computers?

→ Intersection determines equilibrium price

Home:



1) In the figure, trade for the Home country is:

a. $X_C = 20$, $M_S = 20$;

b. $X_C = 25$, $M_S = 35$;

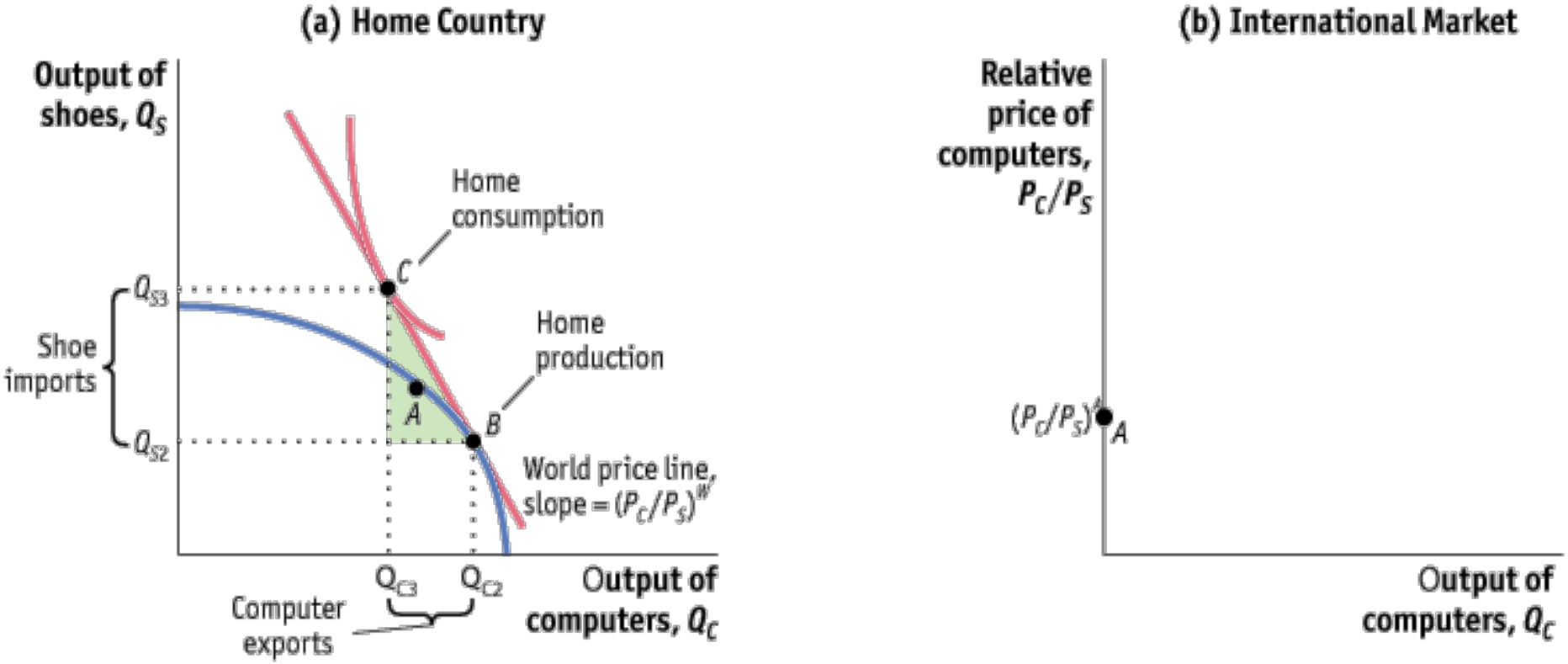
c. $X_C = 25$, $M_S = 15$;

d. $X_C = 5$, $M_S = 20$;

e. $X_C = 35$, $M_S = 25$;

Free-Trade Equilibrium

Home:

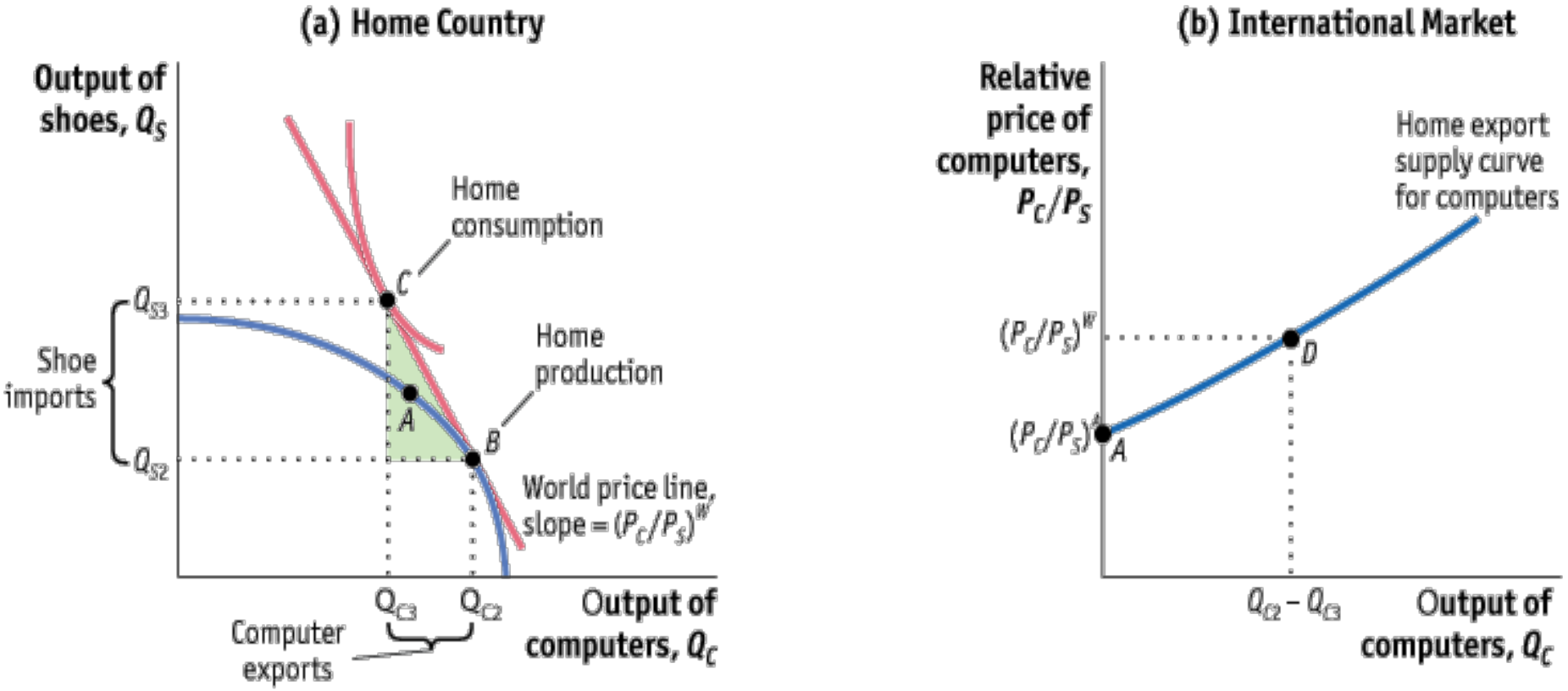


At the free-trade world relative price of computers, $(P_C/P_S)^W$, Home produces at point *B* in panel (a) and consumes at point *C:*

Exporting computers and importing shoes.

Free-Trade Equilibrium

Home:



In panel (b):

- **Home exports of computers** equal to zero at the autarky price, $(P_C/P_S)^A$,
- equal to $(Q_{C2} - Q_{C3})$ at free-trade relative price $(P_C/P_S)^W$

Heckscher-Ohlin Model

Steps to draw the export supply curve:

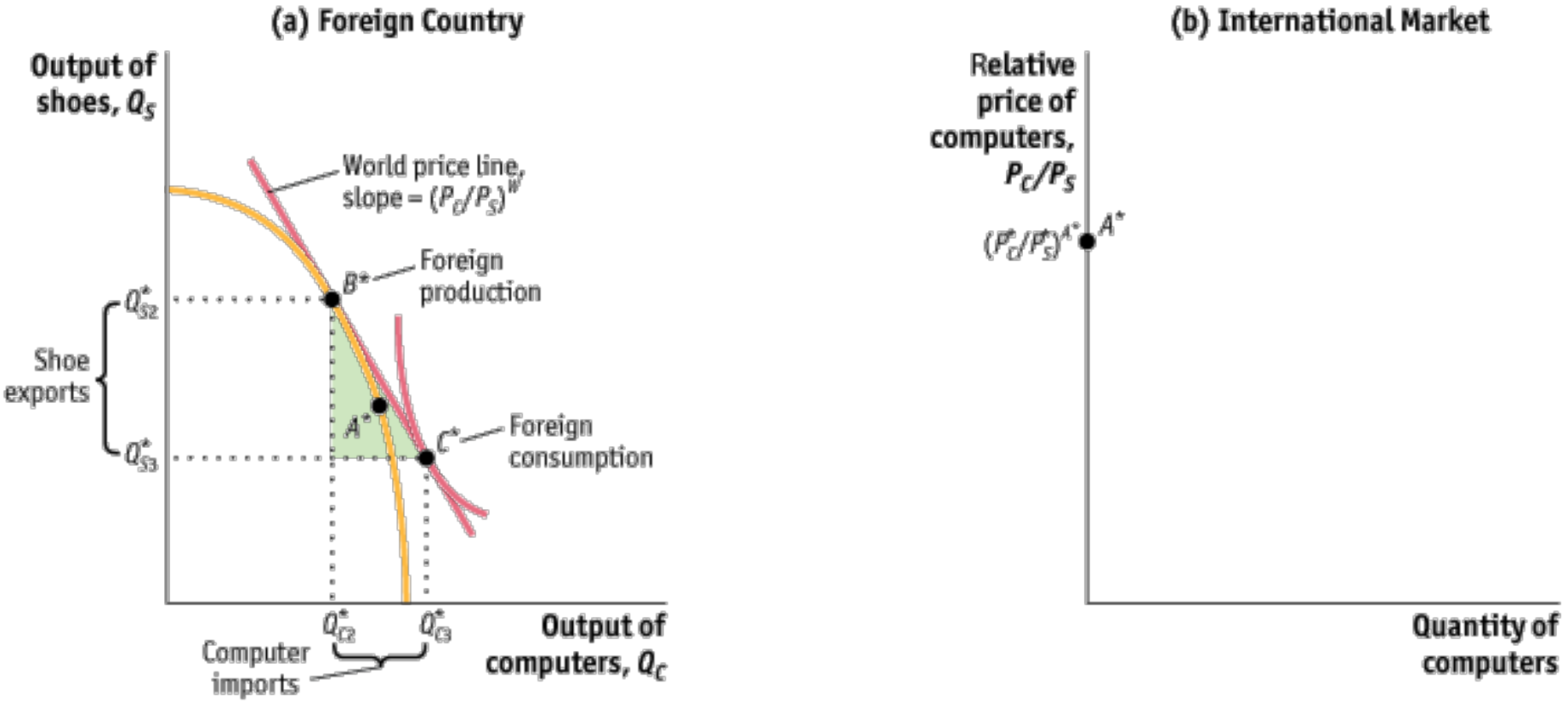
For ***each*** relative price P_C / P_S:

- Determine the optimal production point on the PPF (where the slope of the PPF equals P_C / P_S)
- Draw the new budget line (slope given by P_C / P_S)
- Determine the new consumption basket on the budget line (tangency to an indifference curve)

→ **Exports** (depending on P_C / P_S) correspond to the difference between production and consumption

Free-Trade Equilibrium

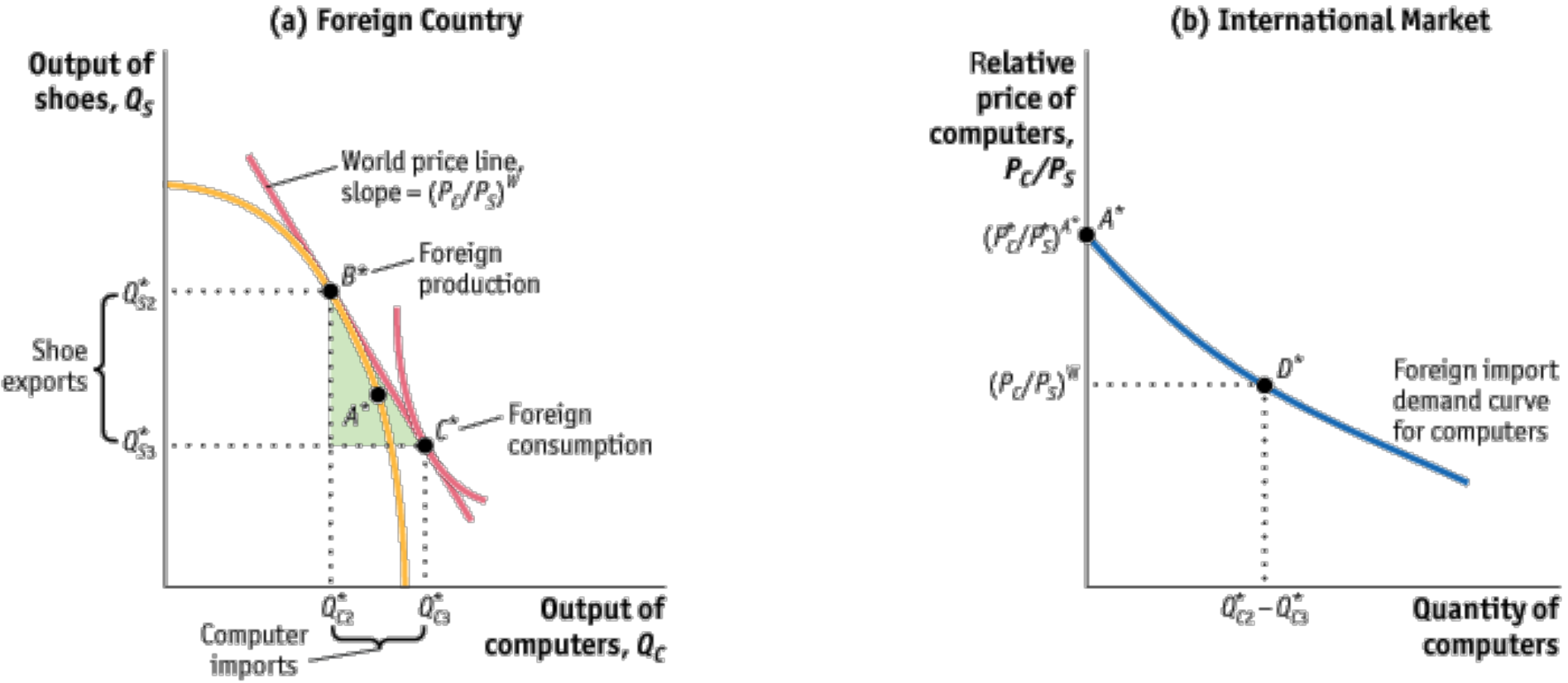
Foreign:



At the free-trade world relative price $(P_C/P_S)^W$, Foreign produces at point B^* in panel (a) and consumes at point C^*, **importing computers and exporting shoes.**

Free-Trade Equilibrium

Foreign:



In panel (b):

- Foreign imports no computers at autarky price $(P^*_C/P^*_S)^{A*}$
- imports equal to $Q^*_{C3} - Q^*_{C2}$ at the free-trade price $(P_C/P_S)^W$

Heckscher-Ohlin Model

Same steps to draw the import demand curve:

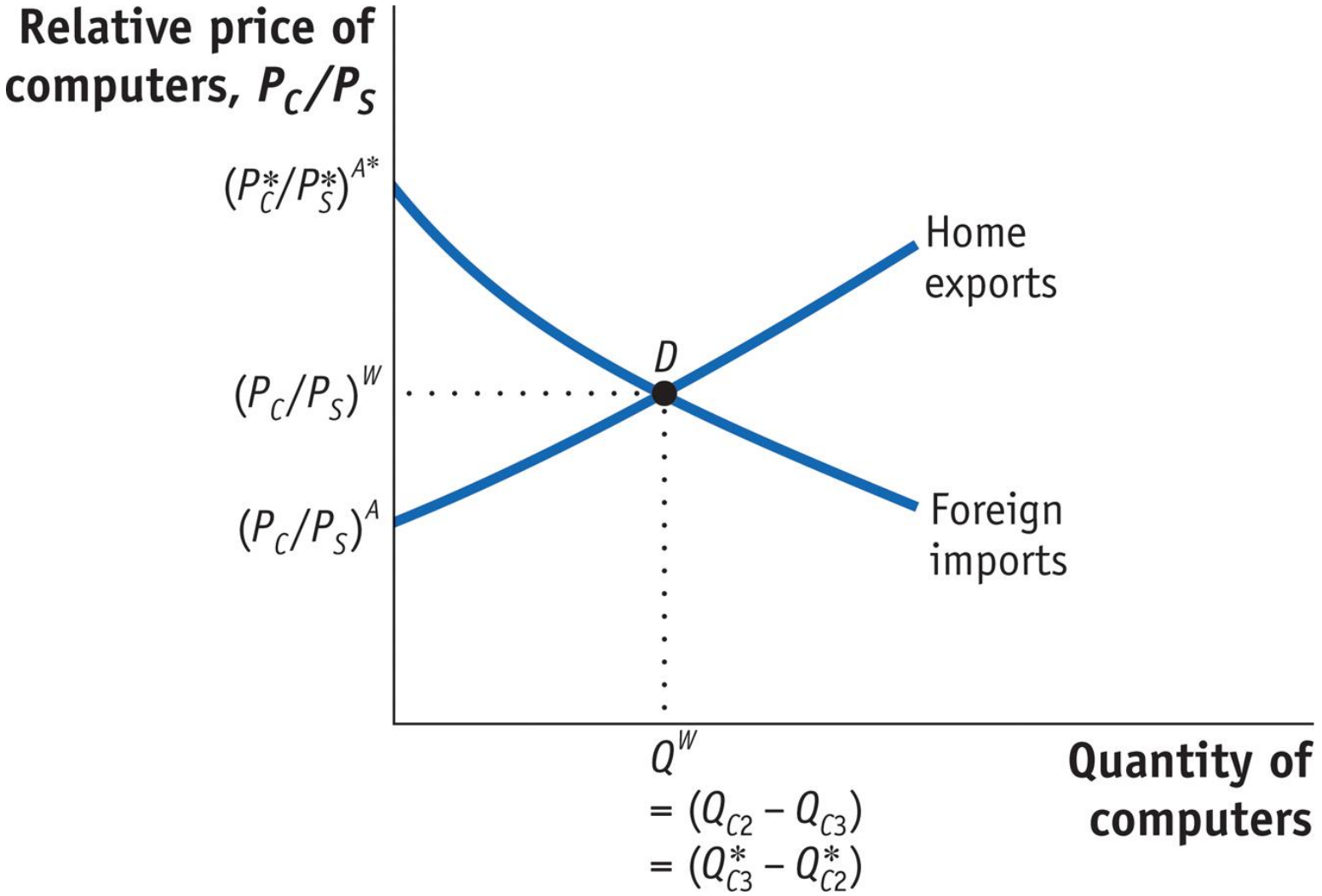
For ***each*** relative price P_C / P_S:

- Determine the optimal production point on the PPF (where the slope of the PPF equals P_C / P_S)
- Draw the new budget line (slope given by P_C / P_S)
- Determine the new consumption basket on the budget line (tangency to an indifference curve)

→ **Imports** (depending on P_C / P_S) correspond to the difference between consumption and production

Free-Trade Equilibrium

Home Exports of computers equal Foreign Imports of computers:



Heckscher-Ohlin Model

Free-Trade Equilibrium

Pattern of Trade

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

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

This result is called the Heckscher-Ohlin theorem.

Heckscher-Ohlin Model

Heckscher-Ohlin Theorem:

Assumption 1: L and K are mobile between the industries.

Assumption 2: The production of shoes is labor intensive as compared with computer production (K 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.

Heckscher-Ohlin Model in the data

HO model in the data?

- Leontief paradox
- When is a factor “abundant” or “scarce” when there are many countries and many factors?
- Do countries export in industries that are intensive the factors that are abundant in these countries?

➔ Testable extensions of H-O model and “sign test”:
“**Heckscher-Ohlin-Vanek** Model”

Heckscher-Ohlin Model in the data

How to test the HO model?

Leontief (1953) computes the labor and capital requirements (based on US data) corresponding to US trade in 1947:

Exports:

Capital: $2.5M Labor: 182

➔ Capital / labor ratio of **$13,900**

Imports:

Capital: $3.1M Labor: 170

➔ Capital / labor ratio of **$18,200**

Heckscher-Ohlin Model in the data

Leontief Paradox

Leontief (1953):

Finds that US exports are less Capital-intensive than US imports?

How to explain that?

Heckscher-Ohlin Model in the data

What explains Leontief Paradox? Your guess:

a) US and foreign technologies are not the same
(Different productivities of labor)

b) Only Capital and Labor / Land is ignored
And Labor should be disaggregated by skills

c) Unusual data for 1947 (end of war/trade balance?)

d) No free trade, large transport costs

e) We should examine bilateral trade flows rather than multilateral trade

Heckscher-Ohlin Model in the data

Criticisms to Leontief Paradox:

- All of these are valid concerns
- Leamer (1980) later found that 1947 data are too unbalanced (end of war) and explain weird results
  → **answer c)**
- Trefler (1993) pointed out again that puzzle still remains if we conduct other tests
- Differences in Technology are the main culprit:
  → **answer a)**

Heckscher-Ohlin Model in the data

How to determine whether a country is abundant in Capital or Labor?

- With just two countries:

Home country is abundant in K if K/L > K*/L*

- How to generalize with more than two countries?

Compare the share of capital in the country (relative to K in the world) to the share s_c of GDP relative the world.

➔ If its share of a factor exceeds (resp. not **exceeds**) its share of world GDP, then we say that the country is ***"abundant in that factor"*** (resp. "**scarce**")

Heckscher-Ohlin Model in the data

"Factor content" of trade

- To examine the predictions of the HO model, we usually examine the "net factor content of trade"
- Idea: When Home exports computers and imports shoes, it's ***as if*** Home exports capital and imports labor.

Definition:

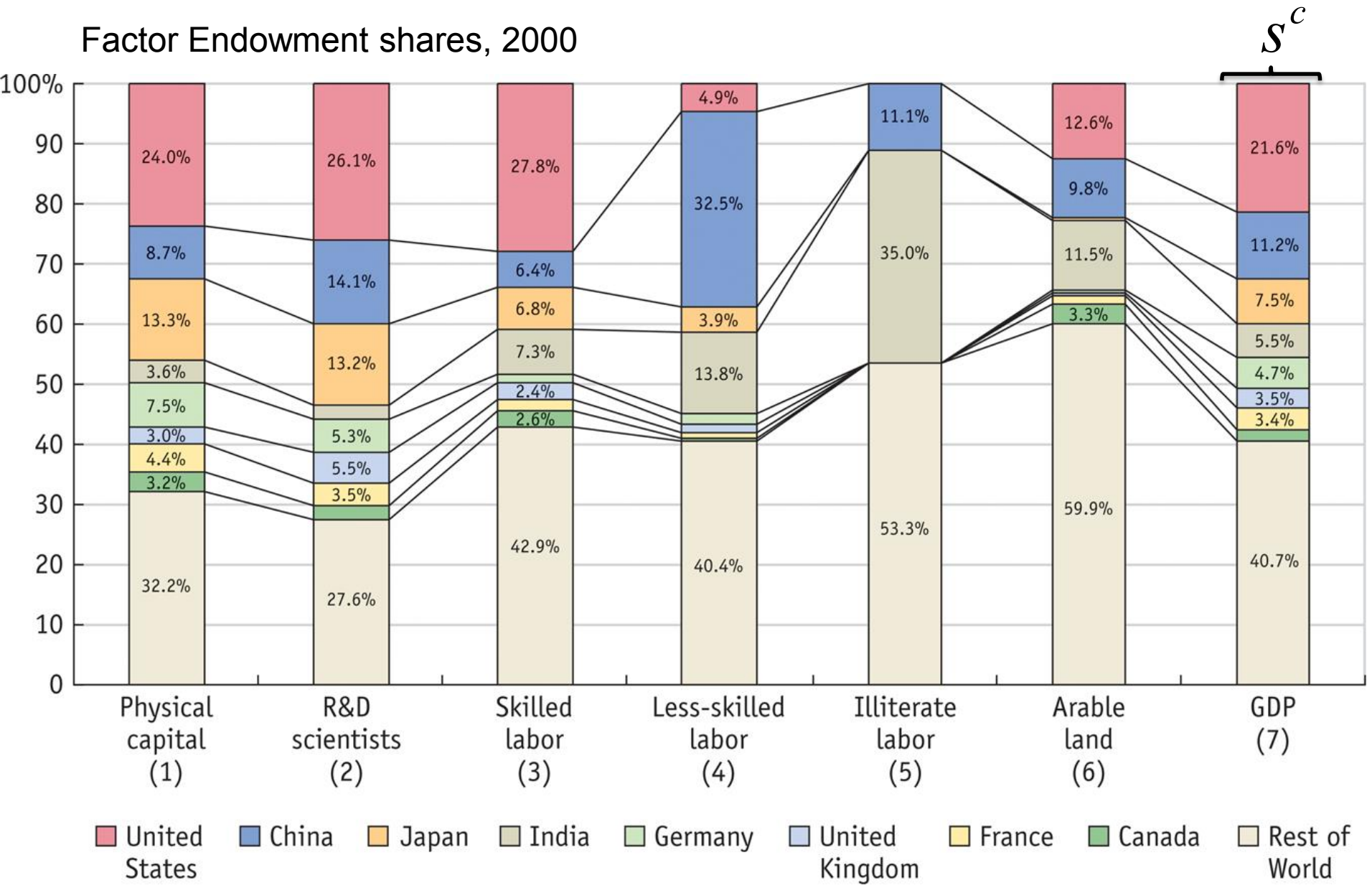
The **net factor content of trade** for a factor (K, L) equals how much of that factor has been used to produce exports minus how much has been used to produce imports.

Heckscher-Ohlin Model in the data

HO Model prediction (a.k.a. "**Sign Test**"):

Theorem:
If a country's share of a factor exceeds its share of world GDP, i.e. if it is ***"abundant in that factor"***, then the net content of trade in that factor should be positive.

- **Example:** if a country has 10% world GDP and more than 10% of world labor, it is abundant in labor.
- In that case, it should have a ***"positive net labor content of trade"***: the amount of labor used to produce exports should exceed the amount of labor used by other countries to produce its imports.


Factor Endowment shares, 2000
S^c
100%
90
80
70
60
50
40
30
20
10
0
24.0%
8.7%
13.3%
3.6%
7.5%
3.0%
4.4%
3.2%
32.2%
26.1%
14.1%
13.2%
5.3%
5.5%
3.5%
27.6%
27.8%
6.4%
6.8%
7.3%
2.4%
2.6%
42.9%
4.9%
32.5%
3.9%
13.8%
40.4%
11.1%
35.0%
53.3%
12.6%
9.8%
11.5%
3.3%
59.9%
21.6%
11.2%
7.5%
5.5%
4.7%
3.5%
3.4%
40.7%
Physical capital (1)
R&D scientists (2)
Skilled labor (3)
Less-skilled labor (4)
Illiterate labor (5)
Arable land (6)
GDP (7)
United States
China
Japan
India
Germany
United Kingdom
France
Canada
Rest of World

Heckscher-Ohlin Model in the data

Empirical test:

Results of the sign test
(from Bowen, Leamer and Sveikauskas 87, Trefler 93)

Q: when a country is abundant in a factor (e.g. K,L), does it have a positive net content of trade in that factor?

In the data:
The sign test is verified in **50% of the cases**

➔ **Not better than a coin toss!!!!**

Heckscher-Ohlin Model in the data

Differing Productivities across Countries

Back to Leontief paradox:

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

Heckscher-Ohlin Model in the data

Differing Productivities across Countries

Measuring Factor Abundance Once Again

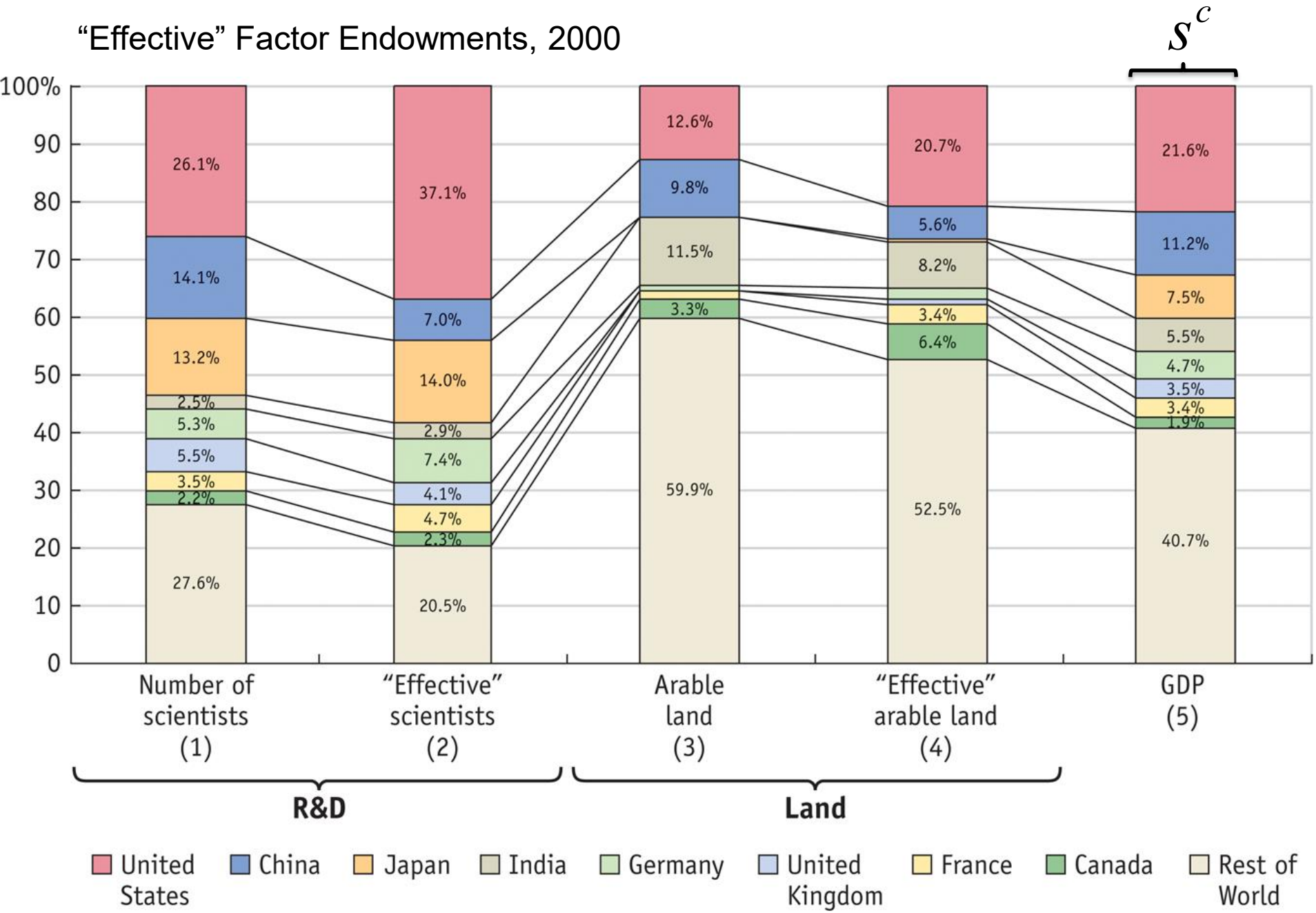
To allow for differences in productivity, we define:

Effective factor endowment =

Actual factor endowment • *Factor productivity*

➔ 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.

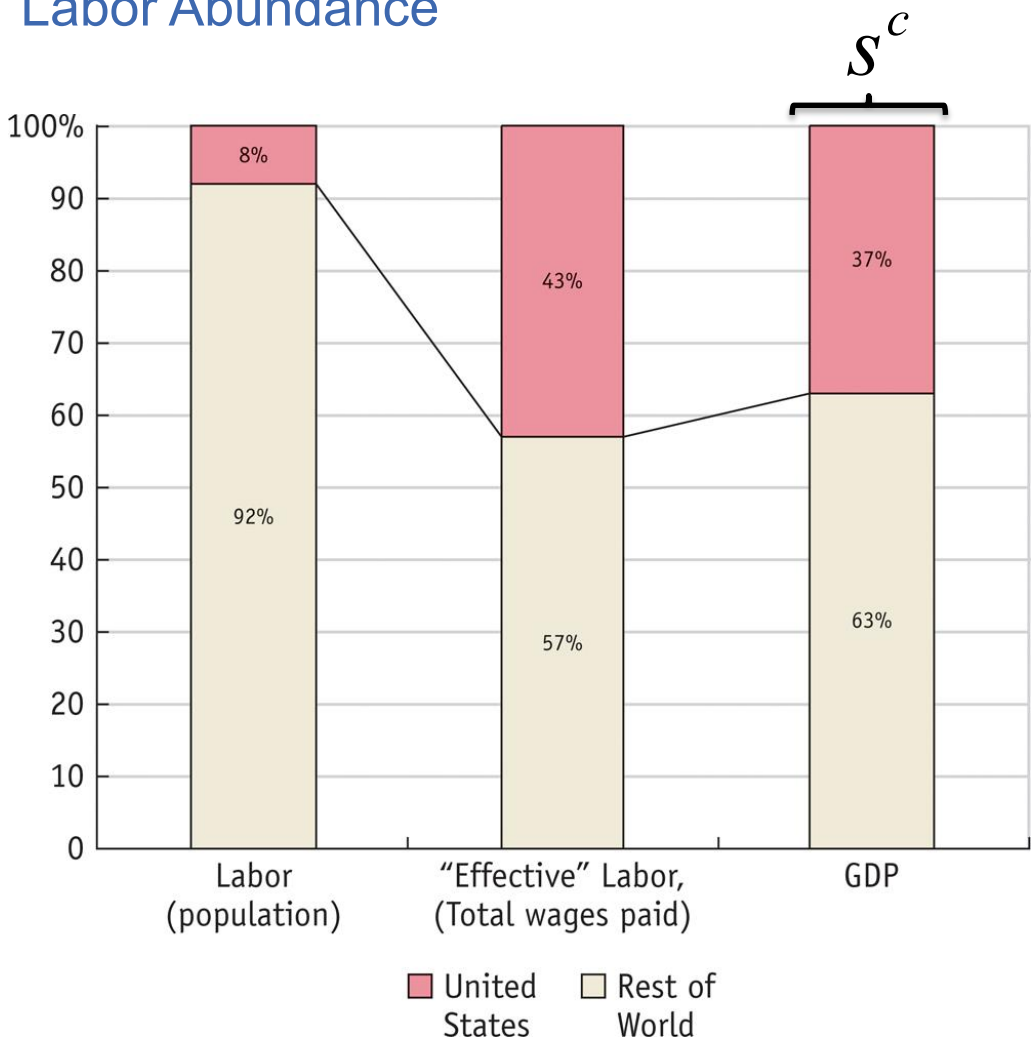
“Effective” Factor Endowments, 2000



Heckscher-Ohlin Model in the data

Leontief's Paradox Once Again

Labor Abundance



In 1947, the US had only 8% of the world's population, but 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*.

Heckscher-Ohlin Model in the data

Empirical test:

RESULTS of the SIGN test:

→ The sign test is verified in 2/3rd of the cases once we allow for cross-country differences in productivity

Country Group	GDP per Capita (% of U.S. GDP)	Number of Factors Passing Sign Test	Number of Factors Failing Sign Test
Lowest GDP per capita	4–33	5.9	3.1
Middle GDP per capita	33–66	5.7	3.3
Highest GDP per capita	66–100	5.3	3.7
All countries	4–100	5.6	3.4

Heckscher-Ohlin Model in the data

Empirical test:

How can we improve the results on the sign test?
By accounting for:

- Differences in input requirements:
→ Sign test verified in 83% of the cases

- Trade costs + differences in input requirements:
→ Sign test verified in 89% of the cases

(source: Davis and Weinstein 2001)

Heckscher-Ohlin Model in the data

Conclusion

- The main prediction of Heckcher-Ohlin model does not seem to fit well with the data
- But slight modifications of HO work well, in particular once we account for differences in productivity across countries.
- In the next lectures, we will see other applications of HO:
  - Understanding the effect of trade on inequality
  - Understanding the effect of FDI and migration