

ECO 364 - Topic 4

The Heckscher-Ohlin Model

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- Fact 1 : Although productivity of American workers has gone up, real wages have stagnated for the last 30 years.
- Fact 2 : Inequality in wages has increased substantially in the last 30 years, with the 90th percentile wage rising by 30 percent while the 20th percentile wage falling by 8 percent.
- Fact 3 : The U.S. economy has become much more integrated with the global economy in the last 30 years.

- It is easy to jump into the conclusion that low wage workers in the U.S. have lost out because of globalization.
- But one needs to be careful - correlation and causation are not the same thing.
- Both globalization and the rising inequality could have been caused by different factors or a common factor.
- Economists have developed a model that allows us to draw a link between trade and wages.

- In the 1920s, Swedish economists Eli Heckscher and Bertil Ohlin developed an alternative to the Ricardian trade model.
- They assumed away with technological differences across countries and instead used the uneven distribution of resources across countries to explain trade patterns.
- One could think of the specific-factors model as the short run version of the Heckscher-Ohlin model.

- Two countries - Home and Foreign
- Two goods - Computers (C) and Shoes (S)
- Two factors - Capital (K) and Labor (L)
- Full employment in Home implies that

$$K_C + K_S = \bar{K}.$$

$$L_C + L_S = \bar{L}.$$

- Full employment in Foreign implies that

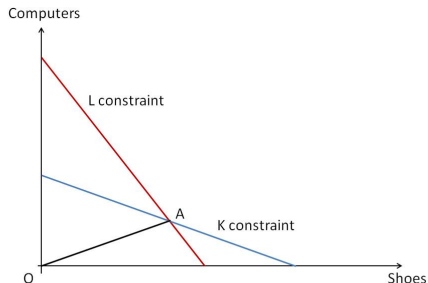
$$K_C^* + K_S^* = \bar{K}^*.$$

$$L_C^* + L_S^* = \bar{L}^*.$$

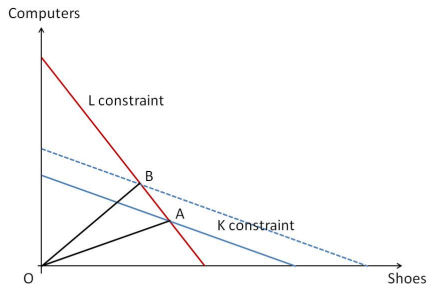
- Factors are freely mobile across sectors *within* a country, but not *across* countries.
- Computer production is relatively capital intensive, i.e., for given factor prices, the ratio of capital to labour used in computer production is higher than the corresponding ratio in shoe production.
- Home is relatively capital abundant, i.e. $\frac{\bar{K}}{\bar{L}} > \frac{\bar{K}^*}{\bar{L}^*}$.
- The technology for producing both goods is the same in the two countries.
- Consumers in both countries have identical tastes, which is independent of their level of income (homothetic preferences).

The HO model centers around four theorems:

- ① Rybczynski Theorem
- ② Heckscher-Ohlin Theorem
- ③ Stolper-Samuleson Theorem
- ④ Factor Price Equalization Theorem



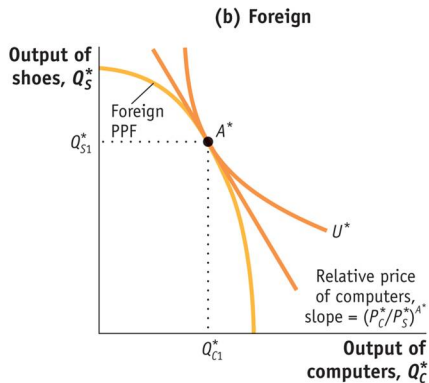
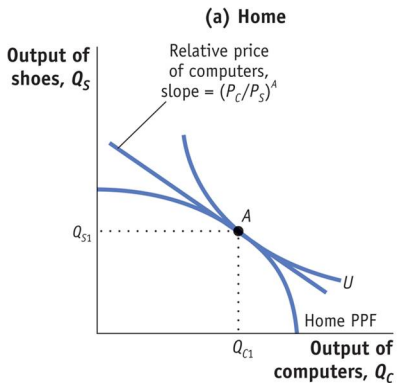
- Along the labour constraint, the labour market clears.
- Same holds for the capital constraint.
- Full employment requires that the country produce at A .
- The ratio of computers to shoes is the slope of OA .



- As capital increases, the equilibrium shifts to B .
- The ratio of computers to shoes is the slope of OB .
- The output of the capital-intensive good rises.
- At the same time, the output of the labour-intensive good falls.

Rybczynski Theorem : At constant relative goods prices, a rise in the endowment of one factor will lead to a more than proportional expansion in the output of the good that uses that factor intensively, and an absolute decline of the output of the other good.

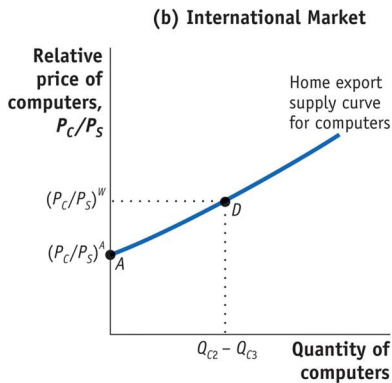
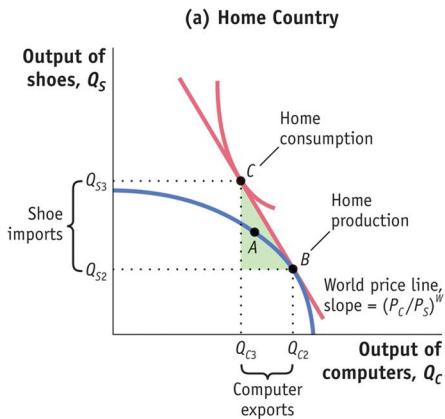
- The increase in the output of the good that intensively uses the expanding factor is intuitive.
- What is less intuitive is why the output of the other good must fall.
- The key assumption is that factor markets must clear.



- Since Foreign country is labor-abundant and shoe production is labor-intensive, the autarky relative price of shoe is lower in Foreign.
 \implies Foreign country has comparative advantage in the production of shoes.
- Reflects the fact that Foreign country's resources are better suited to the production of shoes.
- Similarly, Home country has comparative advantage in the production of computers.

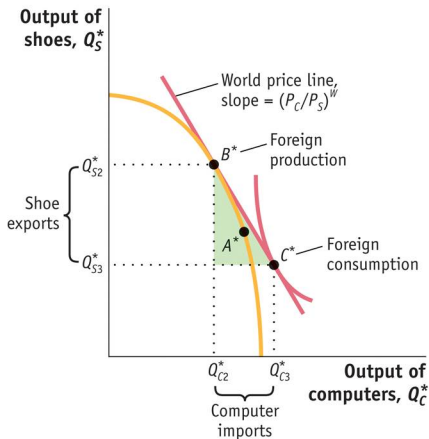
- Difference in autarky relative price of computers create opportunity for trade.
- Home export supply of computers.
- Foreign import demand for computers.

Home export supply of computers

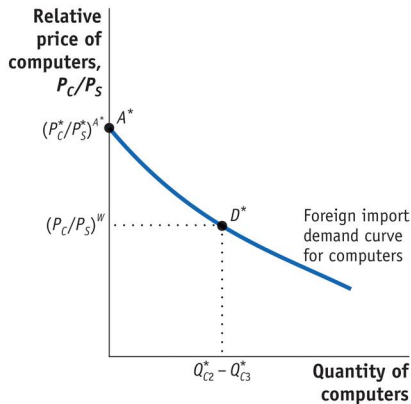


Foreign import demand for computers

(a) Foreign Country



(b) International Market



Relative price of computers, P_C/P_S

$$(P_C^*/P_S^*)^{A^*}$$

$$(P_C/P_S)^W$$

$$(P_C/P_S)^A$$

Home exports

Foreign imports

D

$$Q^W$$

$$= (Q_{C2} - Q_{C3})$$

$$= (Q_{C3}^* - Q_{C2}^*)$$

Quantity of computers

- Let a_i^j denote the j -th factor requirement for producing one unit of good i .
- Factor market clearing implies that

$$a_S^L S + a_C^L C = \bar{L}.$$

$$a_S^K S + a_C^K C = \bar{K}.$$

- If shoe is more labor-intensive, we must have

$$\frac{a_S^L}{a_S^K} > \frac{a_C^L}{a_C^K}.$$

- The relative supply of computers at Home can be solved as:

$$\frac{C}{S} = \frac{a_S^L \bar{K} - a_S^K \bar{L}}{a_C^K \bar{L} - a_C^L \bar{K}}$$

- Re-write $\frac{C}{S}$ as

$$\frac{C}{S} = \frac{a_S^L \left(\frac{\bar{K}}{L} \right) - a_S^K}{a_C^K - a_C^L \left(\frac{\bar{K}}{L} \right)}$$

- Similarly, $\frac{C^*}{S^*}$ can be written as

$$\frac{C^*}{S^*} = \frac{a_S^L \left(\frac{\bar{K}^*}{L^*} \right) - a_S^K}{a_C^K - a_C^L \left(\frac{\bar{K}^*}{L^*} \right)}$$

- Because Home is capital abundant, $\frac{\bar{K}}{L} > \frac{\bar{K}^*}{L^*} \implies \frac{C}{S} > \frac{C^*}{S^*}$.
- If preferences are identical and homothetic, $\frac{C_d}{S_d} = D\left(\frac{p_C}{p_S}\right)$, $D' < 0$.
- Then $\frac{C}{S} > \frac{C^*}{S^*} \implies \frac{p_C}{p_S} < \frac{p_C^*}{p_S^*}$.

Heckscher-Ohlin (HO) Theorem : With two goods and two factors, each country will export the good that uses intensively the factor of production it has in abundance and will import the other good.

- The HO Theorem shows that resource differences could determine the pattern of trade.
- Even if countries have the same technology, differences in resources could “create” comparative advantage.
- The HO theorem is intuitive but when taken to the data, it has met with mixed success (as we discuss later).

The HO Theorem can explain why developing countries tend to export goods that are intensive in unskilled labour. But the theorem can also explain some “odd” features in the data:

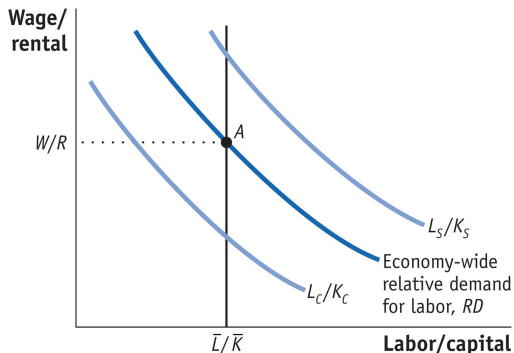
- Americus, a town in Georgia, exports choptsticks to China.
 - Georgia is abundant in poplar and sweet-gum trees, which have the flexibility and toughness required for making chopsticks.
- Kenya is a major supplier of cut flowers, especially roses, to Europe.
 - Kenya's perfect intensity of sunlight and days of near-constant length are ideal for growing roses.

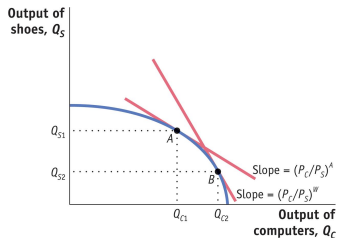
- As countries start to trade, one sector contracts while the other one expands.
- The demand for both factors changes while supply does not.
- This leads to (i) re-allocation of factors across sectors, and (ii) change in factor prices.

- In equilibrium, the relative supply and demand for labor must be equal,

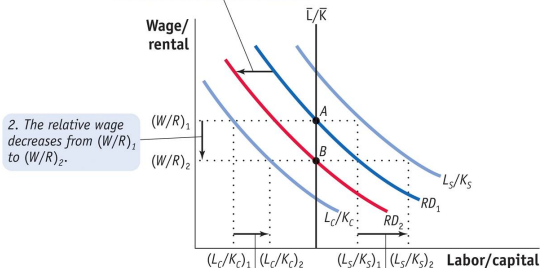
$$\frac{\bar{L}}{\bar{K}} = \frac{L_C + L_S}{\bar{K}} = \frac{L_C}{K_C} \cdot \left(\frac{K_C}{\bar{K}}\right) + \frac{L_S}{K_S} \cdot \left(\frac{K_S}{\bar{K}}\right).$$

- The relative demand is a weighted average of labor-capital ratios in the two sectors since $\frac{K_C}{\bar{K}} + \frac{K_S}{\bar{K}} = 1$.





1. An increase in the relative price of computers shifts the relative demand curve from RD_1 to RD_2 .



2. The relative wage decreases from $(W/R)_1$ to $(W/R)_2$.

3. At the new relative wage, the labor/capital ratio in each industry increases.

- The labor-capital ratio in both industries goes up but the relative demand for labor remains unchanged. How?
- As price of computers increases, computer output rises while shoe output falls.
- But the labor released per unit of capital from the contracting shoe industry cannot be absorbed by the expanding computer industry, leading to excess relative supply of labor.
- As the wage-rental ratio falls, the labor-capital ratios in both industries rise.

- Recall that $a_i^j(W, R)$ is the j -th factor requirement for producing one unit of good i .
- Perfect competition implies that

$$W \cdot a_C^L(W, R) + R \cdot a_C^K(W, R) \geq P_C.$$

$$W \cdot a_S^L(W, R) + R \cdot a_S^K(W, R) \geq P_S.$$

- Under incomplete specialization, the above equations hold with equality. Totally differentiating, we have

$$dW \cdot a_C^L(W, R) + dR \cdot a_C^K(W, R) = dP_C.$$

$$dW \cdot a_S^L(W, R) + dR \cdot a_S^K(W, R) = dP_S.$$

- This can be re-written as

$$\frac{dW}{W} \cdot \theta_C^L + \frac{dR}{R} \cdot \theta_C^K = \frac{dP_C}{P_C}.$$

$$\frac{dW}{W} \cdot \theta_S^L + \frac{dR}{R} \cdot \theta_S^K = \frac{dP_S}{P_S}.$$

where $\theta_C^L = \frac{Wa_C^L}{P_C}$ is the share of labor in the cost of producing one computer.

- Because $\theta_C^L + \theta_C^K = 1$, $\frac{dP_C}{P_C}$ is a weighted average of $\frac{dW}{W}$ and $\frac{dR}{R}$.
- But $\frac{dW}{W} < \frac{dR}{R}$ (because $\frac{W}{R}$ falls).

- Hence,

$$\frac{dW}{W} < \frac{dP_C}{P_C} < \frac{dR}{R}.$$

$$\frac{dW}{W} < \frac{dP_S}{P_S} < \frac{dR}{R}.$$

- Therefore,

$$R/P_C \uparrow \quad R/P_S \uparrow.$$

- Capital owners are unambiguously better off.
- And,

$$W/P_C \downarrow \quad W/P_S \downarrow.$$

- Workers are unambiguously worse off.

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.

- Unlike the specific-factors model, trade creates conflict between mobile factors.
- Combined with the HO Theorem, we can say that in the HO model, the abundant factor gains from trade while the scarce factor loses.

- Under incomplete specialization,

$$W \cdot a_C^L(W, R) + R \cdot a_C^K(W, R) = P_C.$$

$$W \cdot a_S^L(W, R) + R \cdot a_S^K(W, R) = P_S.$$

- These are two equations in two unknowns. Hence, we can solve for a unique (W, R) .
- Because of same technology, the above equations are the same in both countries under free trade.
 \implies Both countries face the same (W, R) under free trade.

Factor Price Equalization Theorem : When both countries incompletely specialize in the production of goods, factor prices are equalized across countries.

- When two countries trade with each other, they do not simply exchange goods; they also trade factors of production.
- More capital is *embodied* in Home's exports than its imports. In effect, Home is exporting capital and in turn, importing labor.
- Even in the absence of factor movements, factor prices are equalized.
⇒ Trade makes factor movement redundant!!

Since there are winners and losers from trade, how do we know that trade raises aggregate welfare?

- Trade raises aggregate welfare since it allows a country to consume at a point that lies outside its production possibility frontier - this is never possible under autarky.
- If the country as a whole gains from trade, then it is possible for the winners to *potentially* compensate the losers and still be better off.
- In fact, when Ricardo proposed his theory of comparative advantage to support the repeal of the Corn Laws, he was aware that some groups would oppose the repeal.
- That is why he chose to emphasize the gains to the entire nation, rather than a particular group.

- While re-distribution may be theoretically possible, it may not always be feasible in the real world.
- In the absence of re-distribution, free trade will not receive the unanimous support of all factors of production.
- In the specific factor model, there is conflict along industry lines - factors in import-competing industries oppose trade while those in export-competing industries support trade.
- In the HO model, in contrast, conflict is along factor lines - the scarce factor opposes trade while the abundant factor supports trade.
- Whether trade is allowed or not depends on which group is better organized, can lobby more effectively, is better represented in the government, etc.

- The first test of the HO model was performed by Russian economist Wassily Leontief in 1953.
- He used data for the U.S. from 1947.

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

- Leontief assumed that the U.S. was capital-abundant in 1947.
- His finding contradicted the HO Theorem and came to be known as the *Leontief Paradox*.

Possible explanations for the Leontief Paradox:

- Leontief only looked at labor and capital. But land was an equally important factor of production in the U.S.
- Leontief used U.S. technology to impute the factor content of U.S. imports. But U.S. and foreign technologies are different.
- Leontief treated the labor used in U.S. exports and imports to be the same. But one needs to distinguish between skilled and unskilled labor.

We consider the first two explanations.

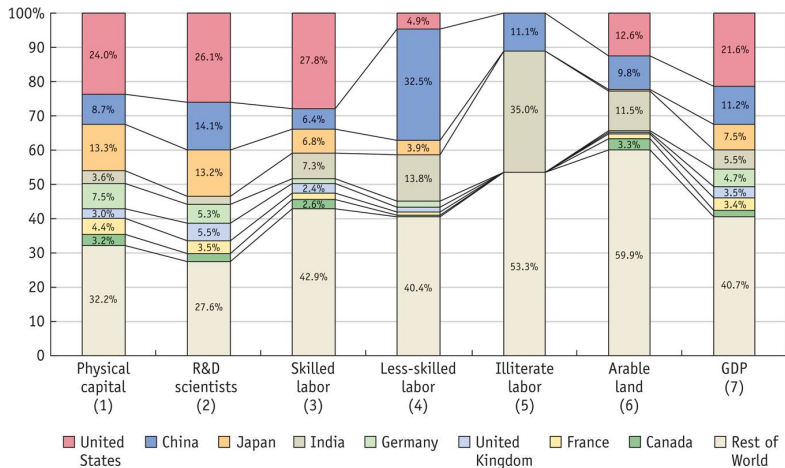
- First, we drop the assumption that there are only two goods and two factors.
- It is not clear anymore how one would measure factor intensity and factor abundance.
- To derive HO-like predictions, use the idea that trade in goods is an indirect way of trading factors of production.

- Instead of measuring factor intensity of exports and imports, compute the factor content of net exports.
- A positive factor content implies that the country is a net exporter of that factor.

Factor content of trade for the U.S., 1947

	EXPORTS, X		IMPORTS, M		NET EXPORTS ($X - M$)
	For \$1 Million Exports	For Total Exports	For \$1 Million Imports	For Total Imports	
Capital (\$ millions)	2.55	42,600	3.1	19,200	23,400
Labor (person-years)	182	3.04 million	170	1.05 million	2 million
Capital/labor (\$/person)	14,000	14,000	18,200	18,200	16,700

- Instead of measuring relative factor endowment in a country, compute the country's share of a factor.
- If this share is greater than its share of world GDP, the country is abundant in that factor.



- Bowen et al considered a sample of 27 countries and 12 factors of production.
- They computed the fraction of countries for which net exports of factor runs in predicted direction.

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.

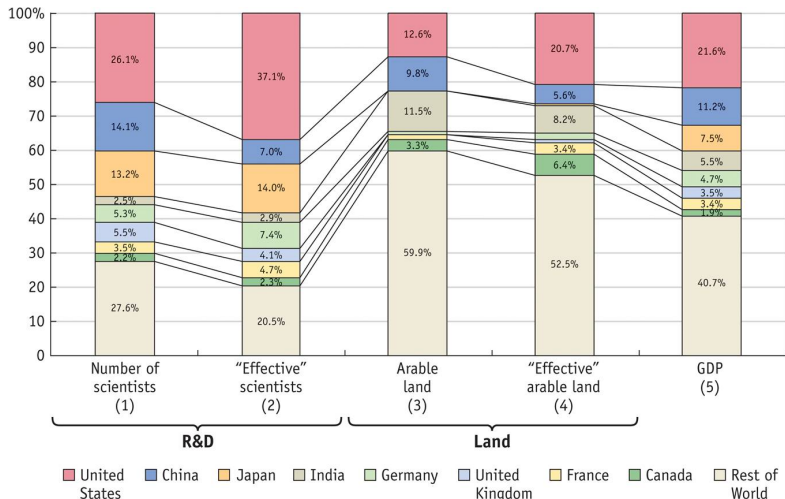
Source: Harry P. Bowen, Edward E. Leamer, and Leo Sveikauskas, "Multicountry, Multifactor Tests of the Factor Abundance Theory," *American Economic Review* 77 (December 1987), pp. 791–809.

- Second, we drop the assumption that countries have the same productivity in all factors.
- To allow factors of production to differ in their productivities, define the *effective factor endowment* as,

Eff. factor endowment = Actual factor endowment · Factor productivity

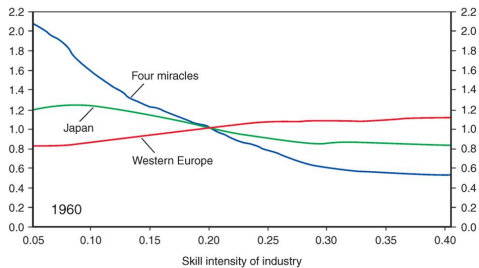
- If a country's share of effective factor exceeds its share of GDP, the country is abundant in that effective factor.

- We look at effective endowments of two factors - scientists and arable land.
- Productivity of scientists can be measured by the R&D expenditure per scientist.



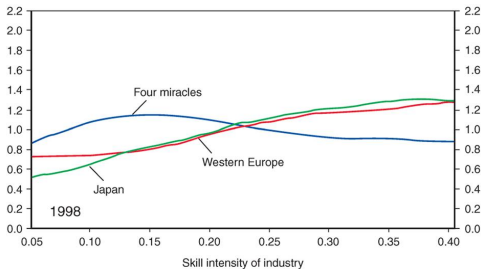
- The pure HO model does not do a great job of explaining trade patterns. But
- the theory performs well if we compare exports of goods between skill-abundant Northern countries and skill-scarce Southern countries,
- and the theory also performs well when looking at changes in factor endowments and trade patterns over time.

Share of U.S. imports by industry



(a) 1960

Share of U.S. imports by industry



(a) 1998