

Chapter 4

Resources,
Comparative
Advantage
and Income
Distribution

With revisions for ANU

Econ 3103/3013/8015

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Slides prepared by Thomas Bishop

Preview

- Production possibilities
- Relationship between goods prices, factor prices and factor levels
- Relationship between goods prices, factor prices, factor levels and output levels.
- Trade in the Heckscher-Ohlin-Samuelson model
- Factor price equalization
- Income distribution and income inequality
- Empirical evidence

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Introduction

- While trade is partly explained by differences in labor productivity, it also can be explained by differences in resources across countries.
- The Heckscher-Ohlin-Samuelson thesis emphasises international differences in labor, labor skills, physical capital or land (factors of production) to explain why trade occurs.
 - ◆ Countries have **relative abundance** of factors of production (say more labour *relative to* capital).
 - ◆ Production processes use factors of production with **relative intensity**.

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Two Factor Heckscher-Ohlin Model

1. Labor and land (or capital) are key factors of production, attracting a wage and a land (machine) rental rate.
2. The amount of labor and land varies across countries, and this variation influences comparative advantage.
3. The supply of labor and land in each country is constant.
4. Only two goods: cloth and food.
5. Competition allows wage and rental rate to depend on productivity and product prices
6. Arbitrage allows factors to move to the industry that pays the highest wage/rental until differences are exhausted.
7. Only two countries: domestic and foreign

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Production Possibilities

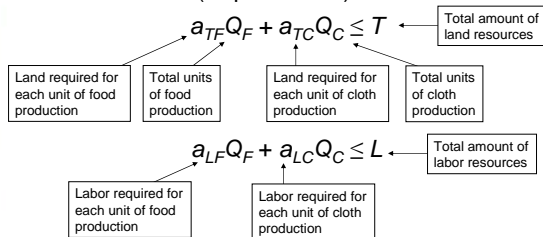
- When there is more than one factor of production, the PPF is no longer a straight line. Why?
- Let's expand the previous chapter's model to include two factors of production, labor and land.
 - ♦ a_{TC} = hectares of land used to produce one m² of cloth
 - ♦ a_{LC} = hours of labor used to produce one m² of cloth
 - ♦ a_{TF} = hectares of land used to produce one calorie of food
 - ♦ a_{LF} = hours of labor used to produce one calorie of food
 - ♦ L = total amount of labor available for production
 - ♦ T = total amount of land (terrain) available for production

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Production Possibilities (cont.)

- Production possibilities are influenced by *both* land and labor (requirements):



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Production Possibilities (cont.)

- Let's assume that *each unit* of cloth production uses labor intensively and *each unit* of food production uses land intensively:
 - $a_{LC}/a_{TC} > a_{LF}/a_{TF}$
 - Or $a_{LC}/a_{LF} > a_{TC}/a_{TF}$
 - Or, we consider the *total* resources used in each industry and say that cloth production is **labor intensive** and food production is **land intensive** if $L_C/T_C > L_F/T_F$.
- This assumption influences the slope of the production possibility frontier:

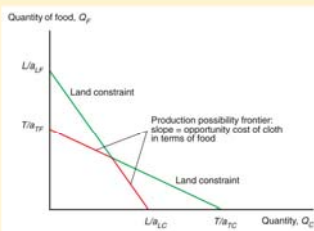
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Production Possibilities (cont.)

Figure 4-1
The Production Possibility Frontier Without Factor Substitution

If land could not be substituted for labor or vice versa, the production possibility frontier in the factor proportions model would be defined by two resource constraints: The economy can't use more than the available supply of labor or land. So the production possibility frontier is defined by the red line in this figure. The important feature of this frontier is that the opportunity cost of cloth in terms of food isn't constant: It rises as the economy's mix of production shifts toward cloth.



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Production Possibilities (cont.)

- The opportunity cost of producing cloth in terms of food is not constant in this model:
 - it's *low* when the economy produces a *low amount of cloth* and a high amount of food
 - it's *high* when the economy produces a *high amount of cloth* and a low amount of food

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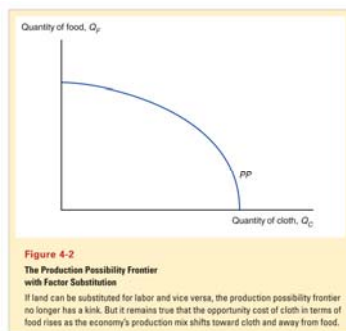
Production Possibilities (cont.)

- The above PPF equations do not allow substitution of land for labor in production or vice versa.
 - ◆ Unit factor requirements are constant along each line segment of the PPF.
- If we allow substitution of inputs, then the PPF becomes curved.
 - ◆ For example, many laborers could work on a small plot of land or a few laborers could work on a large plot of land to produce the same amount of output.
 - ◆ Unit factor requirements are not constant at every quantity of cloth and food produced.

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Production Possibilities (cont.)



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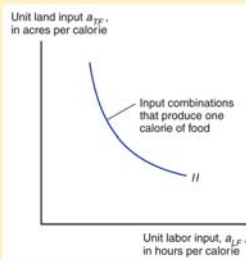
Input Possibilities

Figure 4-4

Input Possibilities in Food Production

A farmer can produce a calorie of food with less land if he or she uses more labor, and vice versa.

In the production of each unit of food, unit factor requirements of land and labor are not constant in the Heckscher-Ohlin model



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Diminishing returns to primary factors

- Another reason the PPF is curved is that there are diminishing returns to factor use
- An industry that already uses a lot of labour will raise its output by adding one more worker, but its MPL will be less than that of a similar industry that uses less labour
- So the opportunity cost of Cloth in terms of Food depends on how much of each is produced

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Production and Prices

- The production possibility frontier describes what an economy can produce, but to determine what the economy does produce, we must determine the prices of goods.
- In general, the economy should produce at the point that maximizes the value of production, V :

$$V = P_C Q_C + P_F Q_F$$

- ♦ where P_C is the price of cloth and P_F is the price of food.

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Production and Prices (cont.)

- Define an **isovalue** line as a line representing a constant value of production.
 - ♦ $\bar{V} = P_C \bar{Q}_C + P_F \bar{Q}_F$
 - ♦ $P_F \bar{Q}_F = \bar{V} - P_C \bar{Q}_C$
 - ♦ $\bar{Q}_F = \bar{V}/P_F - (P_C/P_F) \bar{Q}_C$
 - ♦ The slope of an isovalue line is $-(P_C/P_F)$

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Production and Prices (cont.)

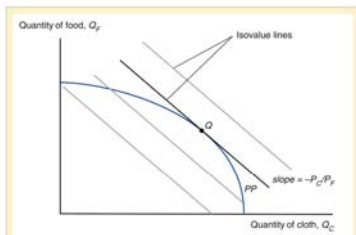


Figure 4-3

Prices and Production

The economy produces at the point that maximizes the value of production given the prices it faces; this is the point that is on the highest possible iso-value line. At the point, the opportunity cost of cloth in terms of food is equal to the relative price of cloth, P_C/P_F .

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Production and Prices (cont.)

- Given prices of output, one iso-value line represents the maximum value of production, say at a point Q.
- At that point, the slope of the PPF equals $-(P_C/P_F)$, so *the opportunity cost of cloth equals the relative price of cloth.*

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Factor Prices, Goods Prices and Factor Levels

- Producers may choose different proportions of factors of production (T/L) to make cloth or food.
- Their choice depends on the wage rate, w , and the (opportunity) cost of using land, the rental rate r .
- As the wage rate increases relative to the rental rate, producers are willing to use more land and less labor in the production of food and cloth.
 - ◆ Recall that food production is land intensive and cloth production is labor intensive.

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Factor Prices, Goods Prices and Factor Levels (cont.)

Figure 4-5

Factor Prices and Input Choices

In each sector, the ratio of land to labor used in production depends on the cost of labor relative to the cost of land, w/r . The curve FF shows the land-labor ratio choices in food production, the curve CC the corresponding choices in cloth production. At any given wage-rental ratio, food production uses a higher land-labor ratio; when this is the case, we say that food production is *land-intensive* and that cloth production is *labor-intensive*.



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Factor Prices, Goods Prices and Factor Levels (cont.)

- Under competition, the price of a good equals the cost of production, and the cost of production depends on the wage rate and the rental rate.
- The effect of the rental rate of land on the price of cloth depends on the intensity of land usage in cloth production.
 - ◆ An increase in the rental rate of land will affect the price of food more than the price of cloth.
- Under competition, changes in w/r are therefore *directly related* to changes in P_C/P_W .

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Factor Prices, Goods Prices and Factor Levels (cont.)

Figure 4-6

Factor Prices and Goods Prices

Because cloth production is labor-intensive while food production is land-intensive, there is a one-to-one relationship between the factor price ratio w/r and the relative price of cloth P_C/P_F ; the higher the relative cost of labor, the higher must be the relative price of the labor-intensive good. The relationship is illustrated by the curve SS .



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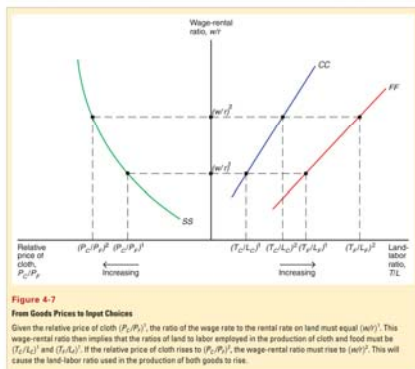
Factor Prices, Goods Prices and Factor Levels (cont.)

- We have a relationship among factor prices and good prices and the levels of factors used in production:
- **Stolper-Samuelson theorem:** if the relative price of a good increases, then the real wage or rate of return of the factor used intensively in the production of that good increases, while the real wage or rate of return of the other factor decreases.
 - ♦ Under competition, the real wage/return is equal to the marginal productivity of the factor.
 - ♦ Marginal productivity of a factor increases as the level of that factor used in production decreases.

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Factor Prices, Goods Prices and Factor Levels (cont.)



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Factor Prices, Goods Prices and Factor Levels (cont.)

- We have a theory that predicts changes in the distribution of income when the relative price of goods changes, say because of trade.
- An increase in the relative price of cloth, P_C/P_F , will:
 - ♦ raise income of workers relative to that of landowners, w/r .
 - ♦ raise the ratio of land to labor, T/L , in both industries and raise the marginal product of labor in both industries and lower the marginal product of land in both industries.
 - ♦ raise the real income of workers and *lower the real income of land owners*.

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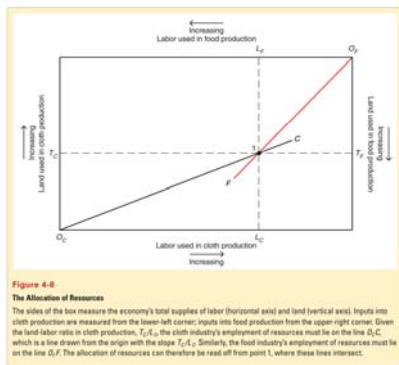
Factor Prices, Goods Prices, Factor Levels and Output Levels

- The allocation of factors used in production determine the level of output at the economy's PPF.
- We summarize the relationship between the levels of factors used in production and output levels, using the following diagram:

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Factor Prices, Goods Prices, Factor Levels and Output Levels (cont.)



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Factor Prices, Goods Prices, Factor Levels and Output Levels (cont.)

- How do output levels change when the economy's resources change?
- If we hold output prices constant as 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*.
 - ♦ This proposition is called the Rybczynski theorem.

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Factor Prices, Goods Prices, Factor Levels and Output Levels (cont.)

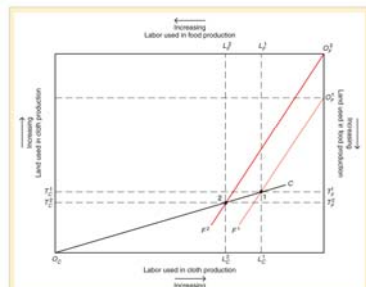
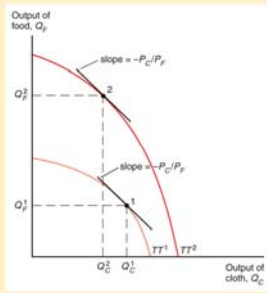


Figure 4-9
An Increase in the Supply of Land
 An increased land supply makes the box representing the economy's resources taller: resources allocated to food production must now be measured from O_2' . If goods prices remain unchanged, and thus factor prices and land-labor ratios remain the same, resources allocation moves from point 1 to point 2, with more land and more labor devoted to food production. The output of clothing falls, while output of food rises more than proportionately to the increase in land supply.

Factor Prices, Goods Prices, Factor Levels and Output Levels (cont.)

Figure 4-10
Resources and Production Possibilities

An increase in the supply of land shifts the economy's production possibility frontier outward from FF^1 to FF^2 , but does so disproportionately in the direction of food production. The result is that at an unchanged relative price of cloth (indicated by the slope $-P_C/P_F$), cloth production actually declines from Q_C^1 to Q_C^2 .



Factor Prices, Goods Prices, Factor Levels and Output Levels (cont.)

- A economy with a *high ratio of land to labor* is predicted to have a *high output of food* relative to cloth and a *low price of food* relative to cloth.
 - It will be relatively efficient at (have a comparative advantage in) producing food.
 - It will be relatively inefficient at producing cloth.
- An economy will be relatively efficient at producing goods that are intensive in the factors of production in which the country is relatively well endowed.

Trade in the Heckscher-Ohlin Model

- Suppose that the domestic country has an abundant amount of labor relative to the amount of land.
 - ♦ The domestic country is **abundant** in labor and the foreign country is **abundant** in land: $L/T > L^*/T^*$
 - ♦ Likewise, the domestic country is **scarce** in land and the foreign country is **scarce** in labor.
 - ♦ However, the countries are assumed to have the same technology and same consumer tastes.
- Because the domestic country is *abundant in labor*, it will be relatively efficient at producing cloth because cloth is *labor intensive*.

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Trade in the Heckscher-Ohlin Model (cont.)

- Since cloth is a labor intensive good, the domestic country's PPF will allow a higher ratio of cloth to food relative to the foreign country's PPF.
- At each relative price, the domestic country will produce a higher ratio of cloth to food than the foreign country.
 - ♦ The domestic country will have a higher relative supply of cloth than the foreign country.

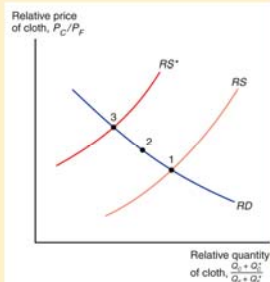
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Trade in the Heckscher-Ohlin Model (cont.)

Figure 4-11
Trade Leads to a Convergence of Relative Prices

In the absence of trade, Home's equilibrium would be at point 1, where domestic relative supply RS intersects the relative demand curve RD . Similarly, Foreign's equilibrium would be at point 3. Trade leads to a world relative price that lies between the pretrade prices, e.g., at point 2.



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Trade in the Heckscher-Ohlin Model (cont.)

- Like the Ricardian model, the Heckscher-Ohlin model predicts a convergence of relative prices with trade.
- With trade, the relative price of cloth will rise in the domestic country and fall in the foreign country.
 - ◆ In the domestic country, 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; the domestic country becomes an exporter of cloth and an importer of food.
 - ◆ The decline in the relative price of cloth in the foreign country leads it to become an importer of cloth and an exporter of food.

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Trade in the Heckscher-Ohlin Model (cont.)

- An economy will be relatively efficient at (have a comparative advantage in) producing goods that are intensive in its abundant factors of production.
- An economy will export goods that are intensive in its abundant factors of production and import goods that are intensive in its scarce factors of production.
 - ◆ This proposition is called the Heckscher-Ohlin theorem

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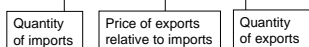
Trade in the Heckscher-Ohlin Model (cont.)

- Over time, the value of goods consumed is constrained to equal the value of goods produced for each country.

$$P_C D_C + P_F D_F = P_C Q_C + P_F Q_F$$

where D_C represents domestic consumption demand for cloth and D_F represents domestic consumption demand for food

$$(D_F - Q_F) = (P_C/P_F)(Q_C - D_C)$$



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Trade in the Heckscher-Ohlin Model (cont.)

$$(D_F - Q_F) = (P_C/P_F)(Q_C - D_C)$$

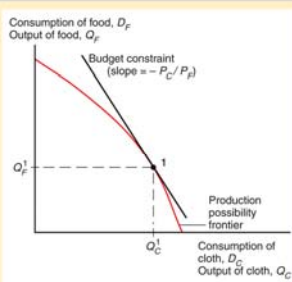
- This equation is the *budget constraint* for an economy, and it has a slope of $-(P_C/P_F)$

$$(D_F - Q_F) - (P_C/P_F)(Q_C - D_C) = 0$$

Trade in the Heckscher-Ohlin Model (cont.)

Figure 4-12
The Budget Constraint for a Trading Economy

Point 1 represents the economy's production. The economy's consumption must lie along a line that passes through point 1 and has a slope equal to minus the relative price of cloth.



Trade in the Heckscher-Ohlin Model (cont.)

- Note that the budget constraint touches the PPF: a country can always afford to consume what it produces.
- However, a country need not consume only the goods and services that it produces with trade.
 - ♦ Exports and imports can be greater than zero.
- Furthermore, a country can afford to consume more of both goods with trade.

Trade in the Heckscher-Ohlin Model (cont.)

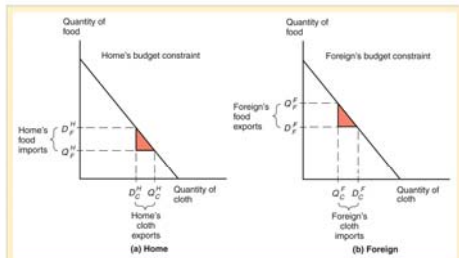


Figure 4-13
Trading Equilibrium
 Home's imports of food are exactly equal to Foreign's exports, and Foreign's imports of cloth are exactly equal to Home's exports.

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Trade in the Heckscher-Ohlin Model (cont.)

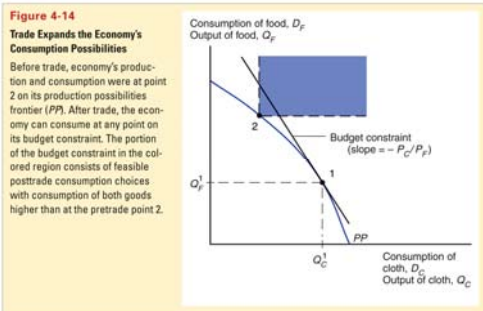


Figure 4-14
Trade Expands the Economy's Consumption Possibilities
 Before trade, economy's production and consumption were at point 2 on its production possibilities frontier (PP). After trade, the economy can consume at any point on its budget constraint. The portion of the budget constraint in the colored region consists of feasible posttrade consumption choices with consumption of both goods higher than at the pretrade point 2.

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Trade in the Heckscher-Ohlin Model (cont.)

- Because an economy can afford to consume more with trade, the country *as a whole* is made better off.
- But *some* do not gain from trade, unless the model accounts for a redistribution of income.
- Trade changes relative prices of goods, which have effects on the relative earnings of labor and land.
 - ◆ A rise in the price of cloth raises the purchasing power of domestic laborers, but lowers the purchasing power of domestic land owners.
- The model predicts that with trade owners of abundant factors gain, but owners of scarce factors lose.

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Factor Price Equalization

- Unlike the Ricardian model, the Heckscher-Ohlin model predicts that factor prices will be equalized among countries that trade.
- Because relative prices are equalized and because of the direct relationship between relative prices and factor prices, factor prices are also equalized.
- Trade increases the demand for goods produced by abundant factors, indirectly increasing the demand for the abundant factors themselves, raising the factor prices of the abundant factors across countries.

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Factor Price Equalization (cont.)

- But factor prices are not really equal across countries.
- The model predicts that trading countries produce the same goods, so that prices for those goods can equalize, but countries may produce different goods.
- The model 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.

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Factor Price Equalization (cont.)

- Trade barriers and transportation costs may prevent goods prices and factor prices from equalizing.
- 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/rate may vary across countries.

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Does Trade Increase Income Inequality?

- Over the last 40 years, countries like South Korea, Mexico and China have exported to the US goods intensive in unskilled labor (e.g., clothing, shoes, toys, assembled goods).
- At the same time, income inequality has increased in the US, as wages of unskilled workers have grown slowly compared to those of skilled workers.
- Did the former trend cause the latter trend?

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Does Trade Increase Income Inequality? (cont.)

- The Heckscher-Ohlin model predicts that owners of abundant factors will gain from trade and owners of scarce factors will lose from trade.
 - But little evidence supporting this prediction exists.
1. According to the model, a change in income distribution occurs through changes in goods prices, but there is no evidence of a change in the prices of skill-intensive goods relative to prices of unskilled-intensive goods.

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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.
3. Even if the model were exactly correct, trade is a small fraction of the US economy, so its effects on US prices and wages prices should be small.

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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.

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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.

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Empirical Evidence of the Heckscher-Ohlin Model

- Tests on US data
 - ◆ Leontief found that US exports were less capital-intensive than US imports, even though the US 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.
- Tests on manufacturing data between low/middle income countries and high income countries.
 - ◆ This data lends more support to the theory.

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

TABLE 4-2 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.

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

TABLE 4-3 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.

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

TABLE 4-4 Trade Between China and Big 3 Advanced Economies, 2003 (billion dollars)

Type of Product	Chinese Exports to Big 3	Chinese Imports from Big 3
Chemicals	8.57	20.08
Nonelectrical machinery	9.00	31.81
Clothing	25.36	0.32
Other consumer goods	46.80	14.58

Source: World Trade Organization.

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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.

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

- But because factor prices are not equalized across countries, the predicted volume of trade is much smaller 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 labor 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.

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Summary

1. Substitution of factors in the production process generates a curved PPF.
 - ◆ When an economy produces a low level of a good, the opportunity cost of producing that good is low.
 - ◆ When an economy produces a high level of a good, the opportunity cost of producing that good is high.
2. When an economy produces on its PPF, the opportunity cost of producing a good equals the relative price of that good.

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Summary (cont.)

3. If the relative price of a good increases, then the real wage or rate of return of the factor used intensively in the production of that good increases, while the real wage or rate of return of the other factor decreases.
4. If we hold output prices constant as 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.

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Summary (cont.)

5. An economy will export goods that are intensive in its abundant factors of production and import goods that are intensive in its scarce factors of production.
6. The Heckscher-Ohlin model predicts that relative output prices and factor prices will equalize, neither of which occurs in the real world.
7. The model predicts that owners of abundant factors gain, but owners of scarce factors lose with trade.

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Summary (cont.)

8. A country as a whole will be better off with trade, even though the model predicts that owners of scarce factors will be worse off without compensation.
9. Empirical support of the Heckscher-Ohlin model is weak except for cases involving trade between high income countries and low/middle income countries.

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TABLE 4-1 Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Production Workers, 2000
United States	100
Germany	121
Japan	111
Spain	55
South Korea	41
Portugal	24
Mexico	12
Sri Lanka*	2

*1999
 Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page*.

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

Country	Efficiency
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Trefler, *American Economic Review* (December 1995), p. 1037.

Figure 4A-1
Choosing the Optimal Land-Labor Ratio

To minimize costs, a producer must get to the lowest possible isocost line; this means choosing the point on the unit isoquant (the curve //) where the slope is equal to minus the wage-rental ratio w/r .

