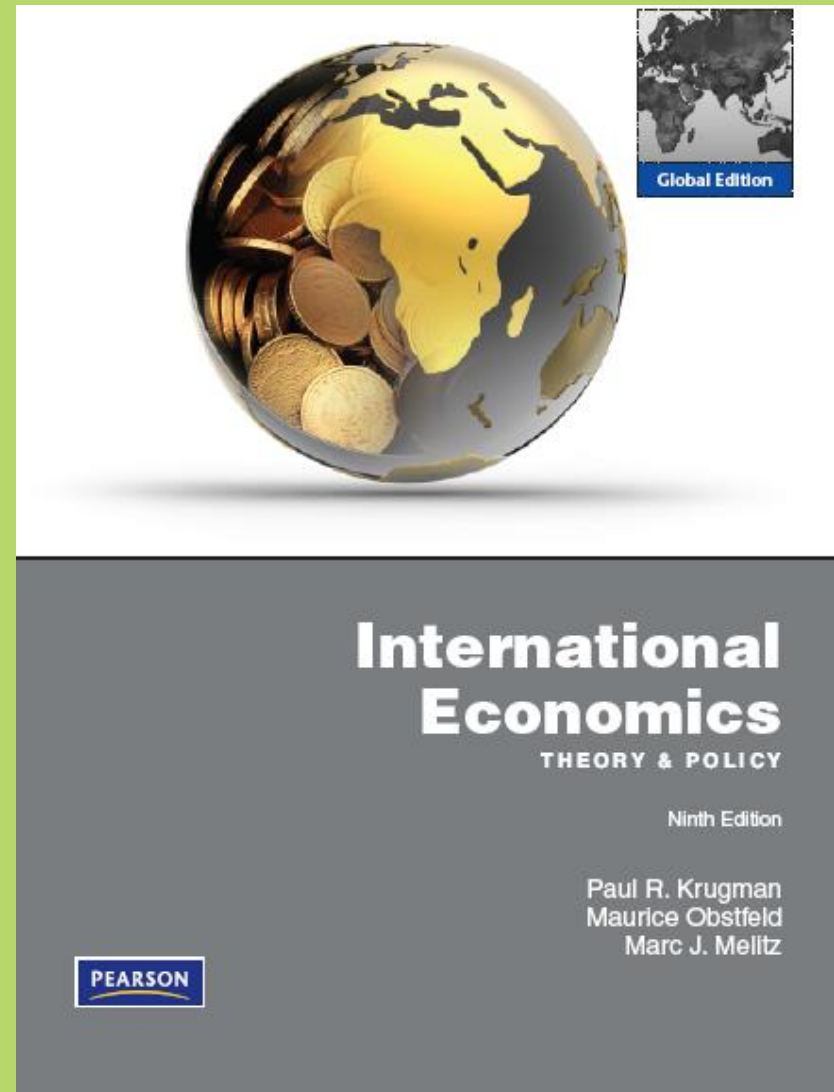


Chapter 3

Labor Productivity and Comparative Advantage: The Ricardian Model



Introduction

- Theories of why trade occurs:
 - Differences across countries in labor, labor skills, physical capital, natural resources, and technology
 - Economies of scale (larger scale of production is more efficient)

Introduction (cont.)

- Sources of differences across countries that lead to gains from trade:
 - The Ricardian model examines differences in the *productivity of labor* (due to differences in *technology*) between countries.
 - The Heckscher-Ohlin model examines differences in *labor, labor skills, physical capital, land, or other factors of production* between countries.

Comparative Advantage and Opportunity Cost

- The Ricardian model uses the concepts of *opportunity cost* and *comparative advantage*.
- The opportunity cost of producing something measures the cost of not being able to produce something else with the resources used.

Comparative Advantage and Opportunity Cost (cont.)

- For example, a limited number of workers could produce either roses or computers.
 - The opportunity cost of producing computers is the amount of roses not produced.
 - The opportunity cost of producing roses is the amount of computers not produced.

Comparative Advantage and Opportunity Cost (cont.)

- Suppose that in the U.S. 10 million roses could be produced with the same resources that could produce 100,000 computers.
- Suppose that in Colombia 10 million roses could be produced with the same resources that could produce 30,000 computers.
- Workers in Colombia would be less productive than those in the U.S. in manufacturing computers.

Comparative Advantage and Opportunity Cost (cont.)

- Colombia has a lower opportunity cost of producing roses.
 - Colombia can produce 10 million roses, compared to 30,000 computers that it could otherwise produce.
 - The U.S. can produce 10 million roses, compared to 100,000 computers that it could otherwise produce.

Comparative Advantage and Opportunity Cost (cont.)

- The U.S. has a lower opportunity cost of producing computers.
 - Colombia can produce 30,000 computers, compared to 10 million roses that it could otherwise produce.
 - The U.S. can produce 100,000 computers, compared to 10 million roses that it could otherwise produce.
 - The U.S. can produce 30,000 computers, compared to 3 million roses that it could otherwise produce.

Comparative Advantage and Opportunity Cost (cont.)

- A country has a **comparative advantage** in producing a good if the opportunity cost of producing that good is lower in the country than in other countries.
 - The U.S. has a comparative advantage in computer production.
 - Colombia has a comparative advantage in rose production.

Comparative Advantage and Opportunity Cost (cont.)

- Suppose initially that Colombia produces computers and the U.S. produces roses, and that both countries want to consume computers and roses.
- Can both countries be made better off?

Table 3-1: Hypothetical Changes in Production

TABLE 3-1 Hypothetical Changes in Production		
	Million Roses	Thousand Computers
United States	- 10	+ 100
Colombia	+ 10	- 30
Total	0	+ 70

Comparative Advantage and Trade

- When countries specialize in production in which they have a comparative advantage, more goods and services can be produced and consumed.
 - Have U.S. stop growing roses and use those resources to make 100,000 computers instead. Have Colombia stop making 30,000 computers and grow roses instead.
 - If produce goods in which have a comparative advantage (U.S. produces computers and Colombia roses), they could still consume the same 10 million roses, but could consume $100,000 - 30,000 = 70,000$ more computers.

A One-Factor Ricardian Model

- The simple example with roses and computers explains the intuition behind the Ricardian model.
- We formalize these ideas by constructing a one-factor Ricardian model using the following assumptions:

A One-Factor Ricardian Model (cont.)

1. Labor is the only factor of production.
2. Labor productivity varies across countries due to differences in technology, but labor productivity in each country is constant.
3. The supply of labor in each country is constant.

A One-Factor Ricardian Model (cont.)

4. Two goods: wine and cheese.
5. Competition allows workers to be paid a “competitive” wage equal to the value of what they produce, and allows them to work in the industry that pays the highest wage.
6. Two countries: home and foreign.

A One-Factor Ricardian Model (cont.)

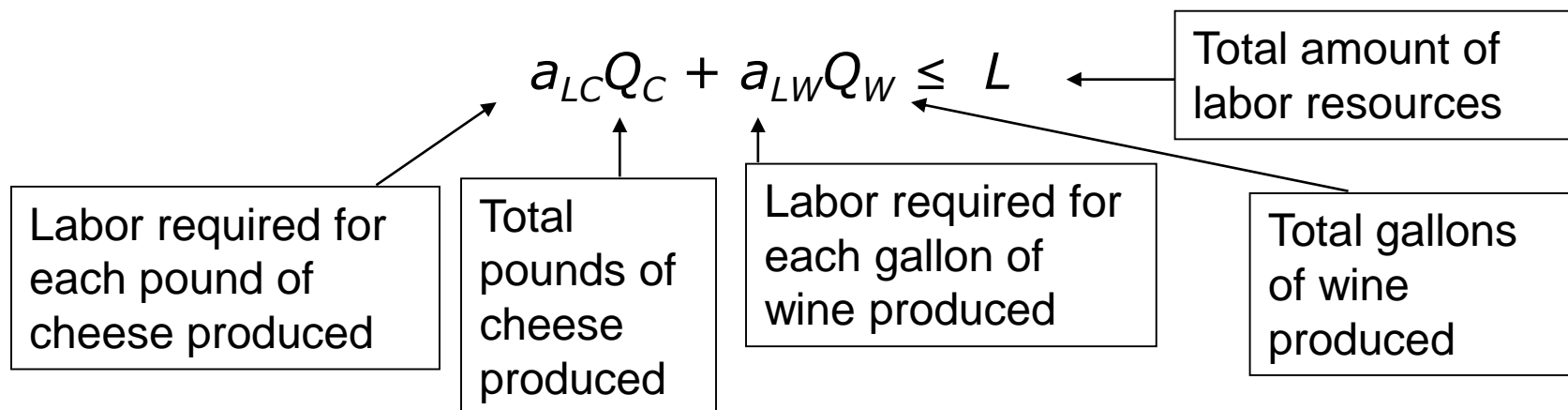
- A **unit labor requirement** indicates the constant number of hours of labor required to produce one unit of output.
 - a_{LC} is the unit labor requirement for cheese in the home country. For example, $a_{LC} = 1$ means that 1 hour of labor produces one pound of cheese in the home country.
 - a_{LW} is the unit labor requirement for wine in the home country. For example, $a_{LW} = 2$ means that 2 hours of labor produces one gallon of wine in the home country.
- A high unit labor requirement means low labor productivity.

A One-Factor Ricardian Model (cont.)

- Labor supply L indicates the total number of hours worked in the home country (a constant number).
- Cheese production Q_C indicates how many pounds of cheese are produced.
- Wine production Q_W indicates how many gallons of wine are produced.

Production Possibilities

- The **production possibility frontier** (PPF) of an economy shows the *maximum* amount of a goods that can be produced for a fixed amount of resources.
- The production possibility frontier of the home economy is:



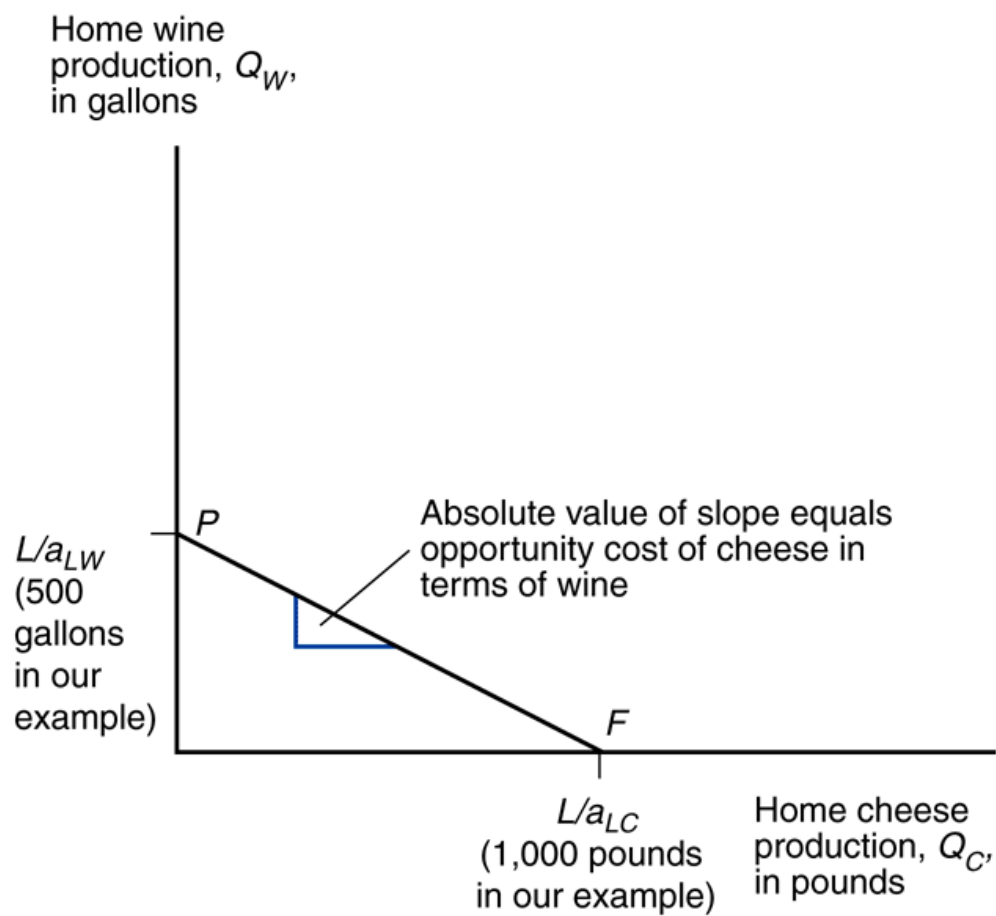
Production Possibilities (cont.)

- Maximum home cheese production is $Q_C = L/a_{LC}$ when $Q_W = 0$.
- Maximum home wine production is $Q_W = L/a_{LW}$ when $Q_C = 0$.

Production Possibilities (cont.)

- For example, suppose that the economy's labor supply is 1,000 hours.
- The PPF equation $a_{LC}Q_C + a_{LW}Q_W \leq L$ becomes $Q_C + 2Q_W \leq 1,000$.
- Maximum cheese production is 1,000 pounds.
- Maximum wine production is 500 gallons.

Fig. 3-1: Home's Production Possibility Frontier



Production Possibilities (cont.)

- The opportunity cost of cheese is how many gallons of wine Home must stop producing in order to make one more pound of cheese:

$$a_{LC}/a_{LW}$$

- This cost is constant because the unit labor requirements are both constant.
- The opportunity cost of cheese appears as the absolute value of the slope of the PPF.

$$Q_W = L/a_{LW} - (a_{LC}/a_{LW})Q_C$$

Production Possibilities (cont.)

- Producing an additional pound of cheese requires a_{LC} hours of labor.
- *Each* hour devoted to cheese production could have been used instead to produce an amount of wine equal to
$$1 \text{ hour} / (a_{LW} \text{ hours/gallon of wine})$$
$$= (1/a_{LW}) \text{ gallons of wine}$$

Production Possibilities (cont.)

- For example, if 1 hour of labor is moved to cheese production, that additional hour could have produced

1 hour / (2 hours/gallon of wine)

= 1/2 gallon of wine.
- Opportunity cost of producing one pound of cheese is 1/2 gallon of wine.

Relative Prices, Wages, and Supply

- Let P_C be the price of cheese and P_W be the price of wine.
- Due to competition,
 - hourly wages of cheese makers equal the value of the cheese produced in an hour: P_C/a_{LC}
 - hourly wages of wine makers equal the value of the wine produced in an hour: P_W/a_{LW}
- Because workers like high wages, they will work in the industry that pays the higher wage.

Relative Prices, Wages, and Supply (cont.)

- If the price of cheese relative to the price of wine exceeds the opportunity cost of producing cheese $P_C/P_W > a_{LC}/a_{LW}$,
 - Then the wage in cheese will exceed the wage in wine $P_C/a_{LC} > P_W/a_{LW}$
 - So workers will make only cheese (the economy specializes in cheese production).

Relative Prices, Wages, and Supply (cont.)

- If the price of cheese relative to the price of wine is less than the opportunity cost of producing cheese $P_C/P_W < a_{LC}/a_{LW}$,
 - then the wage in cheese will be less than the wage in wine $P_C/a_{LC} < P_W/a_{LW}$
 - so workers will make only wine (the economy specializes in wine production).

Production, Prices, and Wages

- If the price of cheese relative to the price of wine equals the opportunity cost of producing cheese $P_C/P_W = a_{LC}/a_{LW}$,
 - then the wage in cheese equals the wage in wine $P_C/a_{LC} = P_W/a_{LW}$
 - so workers will be willing to make both wine and cheese.

Production, Prices, and Wages (cont.)

- For example, suppose cheese sells for $P_C = \$4/\text{pound}$ and wine sells for $P_W = \$7/\text{gallon}$.
 - Wage paid producing cheese is $P_C/a_{LC} = (\$4/\text{pound})(1 \text{ pound}/\text{hour}) = \$4/\text{hour}$.
 - Wage paid producing wine is $P_W/a_{LW} = (\$7/\text{gallon})(1/2 \text{ gallon}/\text{hour}) = \$3.50/\text{hour}$.
 - Workers would be willing to make only cheese (the relative price of cheese $4/7$ exceeds the opportunity cost of cheese of $1/2$).

Production, Prices, and Wages (cont.)

- If the price of cheese drops to $P_C = \$3/\text{pound}$:
 - Wage paid producing cheese drops to $P_C/a_{LC} = (\$3/\text{pound})(1 \text{ pound}/\text{hour}) = \$3/\text{hour}$.
 - Wage paid producing wine is still $\$3.50/\text{hour}$ if price of wine is still $\$7/\text{gallon}$.
 - Now workers would be willing to make only wine (the relative price of cheese $3/7$ is now less than the opportunity cost of cheese of $1/2$).

Production, Prices, and Wages (cont.)

- If the home country wants to consume both wine and cheese (in the absence of international trade), relative prices must adjust so that wages are equal in the wine and cheese industries.
 - If $P_C/a_{LC} = P_W/a_{LW}$ workers will have no incentive to work solely in the cheese industry or the wine industry, so that production of both goods can occur.
 - Production (and consumption) of both goods occurs when the relative price of a good equals the opportunity cost of producing that good:

$$P_C/P_W = a_{LC}/a_{LW}$$

Trade in the Ricardian Model

- Suppose the home country is more efficient in wine and cheese production.
- It has an *absolute advantage* in all production: its unit labor requirements for wine and cheese production are lower than those in the foreign country:

$$a_{LC} < a^*_{LC} \text{ and } a_{LW} < a^*_{LW}$$

Trade in the Ricardian Model (cont.)

- A country can be more efficient in producing both goods, but it will have a comparative advantage in only one good.
- Even if a country is the most (or least) efficient producer of all goods, it still can benefit from trade.

Trade in the Ricardian Model (cont.)

- Suppose that the home country has a comparative advantage in cheese production: its opportunity cost of producing cheese is lower than in the foreign country.

$$a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$$

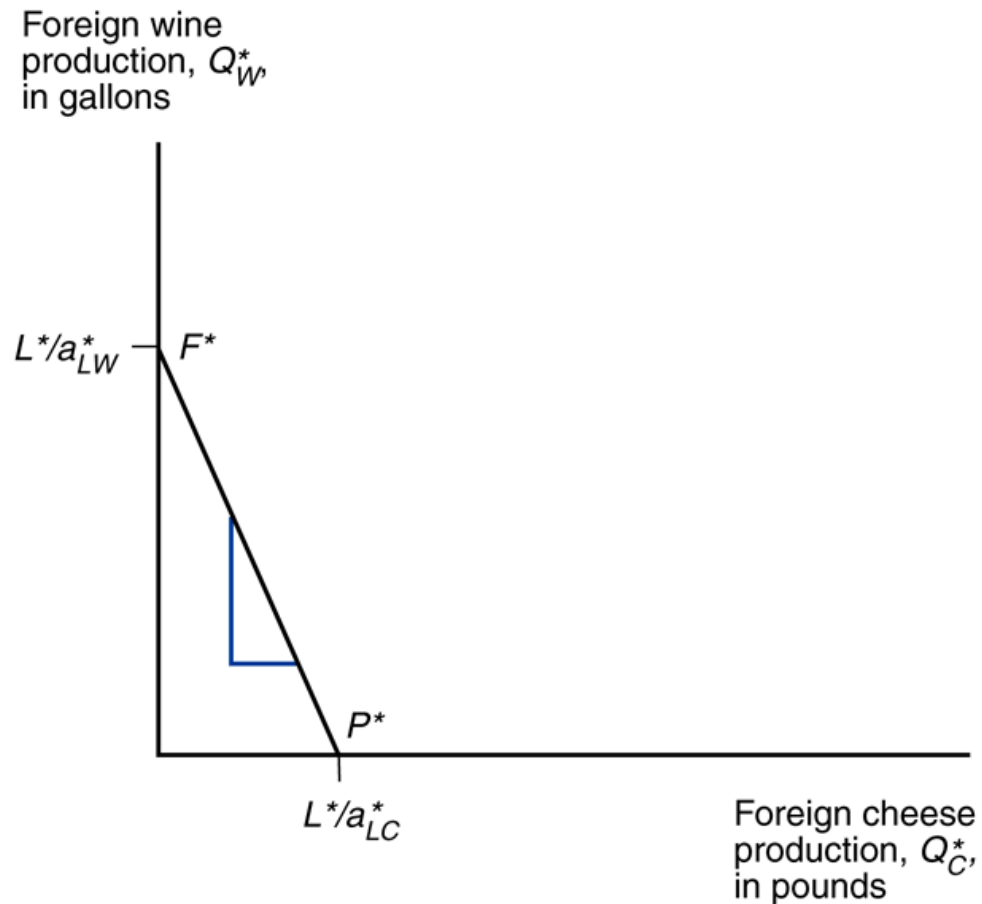
where "*" notates foreign country variables

- When the home country increases cheese production, it reduces wine production less than the foreign country would.

Trade in the Ricardian Model (cont.)

- Since the slope of the PPF indicates the opportunity cost of cheese in terms of wine, Foreign's PPF is steeper than Home's.
 - To produce one pound of cheese, must stop producing more gallons of wine in Foreign than in Home.

Fig. 3-2: Foreign's Production Possibility Frontier



Trade in the Ricardian Model (cont.)

- Before any trade occurs, the relative price of cheese to wine reflects the opportunity cost of cheese in terms of wine in each country.
- In the absence of any trade, the relative price of cheese to wine will be higher in Foreign than in Home if Foreign has the higher opportunity cost of cheese.
- It will be profitable to ship cheese from Home to Foreign (and wine from Foreign to Home) – where does the relative price of cheese to wine settle?

Trade in the Ricardian Model (cont.)

- To see how all countries can benefit from trade, need to find relative prices when trade exists.
- First calculate the world **relative supply** of cheese: the quantity of cheese supplied by all countries relative to the quantity of wine supplied by all countries

$$RS = (Q_C + Q^*_C) / (Q_W + Q^*_W)$$

Relative Supply and Relative Demand

- If the relative price of cheese falls below the opportunity cost of cheese in both countries $P_C/P_W < a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$,
 - no cheese would be produced.
 - domestic and foreign workers would be willing to produce only wine (where wage is higher).

Relative Supply and Relative Demand (cont.)

- When the relative price of cheese equals the opportunity cost in the home country $P_C/P_W = a_{LC}/a_{LW} < a_{LC}^*/a_{LW}^*$,
 - domestic workers are indifferent about producing wine or cheese (wage when producing wine same as wage when producing cheese).
 - foreign workers produce only wine.

Relative Supply and Relative Demand (cont.)

- When the relative price of cheese settles strictly in between the opportunity costs of cheese $a_{LC}/a_{LW} < P_C/P_W < a^*_{LC}/a^*_{LW}$,
 - domestic workers produce only cheese (where their wages are higher).
 - foreign workers still produce only wine (where their wages are higher).
 - world relative supply of cheese equals Home's maximum cheese production divided by Foreign's maximum wine production $(L/a_{LC}) / (L^*/a^*_{LW})$.

Relative Supply and Relative Demand (cont.)

- When the relative price of cheese equals the opportunity cost in the foreign country

$$a_{LC}/a_{LW} < P_C/P_W = a^*_{LC}/a^*_{LW},$$

- foreign workers are indifferent about producing wine or cheese (wage when producing wine same as wage when producing cheese).
- domestic workers produce only cheese.

Relative Supply and Relative Demand (cont.)

- If the relative price of cheese rises above the opportunity cost of cheese in both countries

$$a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW} < P_C/P_W,$$

- no wine is produced.
- home and foreign workers are willing to produce only cheese (where wage is higher).

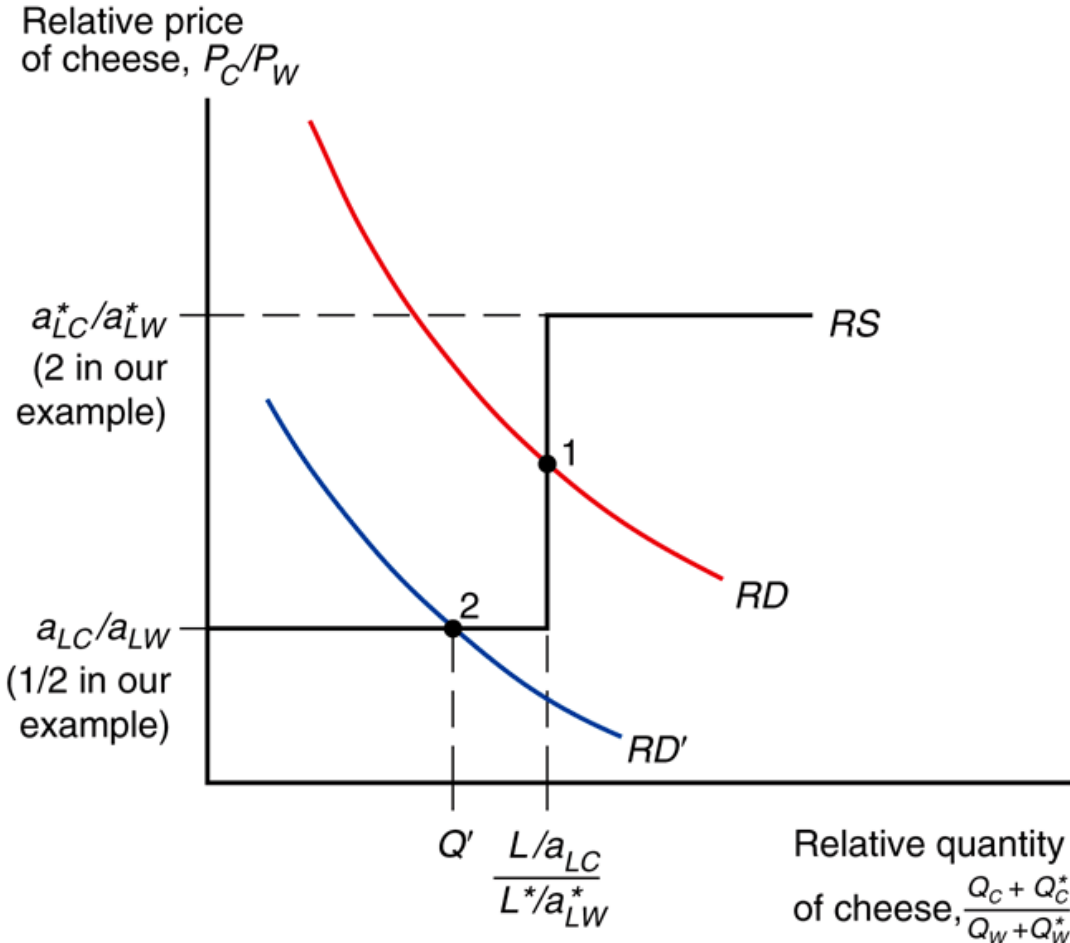
Relative Supply and Relative Demand (cont.)

- World relative supply is a step function:
 - First step at relative price of cheese equal to Home's opportunity cost a_{LC}/a_{LW} , which equals 1/2 in the example.
 - Jumps when world relative supply of cheese equals Home's maximum cheese production divided by Foreign's maximum wine production $(L/a_{LC})/(L^*/a_{LW}^*)$, which equals 1 in the example.
 - Second step at relative price of cheese equal to Foreign's opportunity cost a_{LC}^*/a_{LW}^* , which equals 2 in the example.

Relative Supply and Relative Demand (cont.)

- Relative demand of cheese is the quantity of cheese demanded in all countries relative to the quantity of wine demanded in all countries.
- As the price of cheese relative to the price of wine rises, consumers in all countries will tend to purchase less cheese and more wine so that the relative quantity demanded of cheese falls.

Fig. 3-3: World Relative Supply and Demand



Gains From Trade

- Gains from trade come from specializing in the type of production which uses resources most efficiently, and using the income generated from that production to buy the goods and services that countries desire.
 - where “using resources most efficiently” means producing a good in which a country has a comparative advantage.

Gains From Trade (cont.)

- Domestic workers earn a higher income from cheese production because the relative price of cheese increases with trade.
- Foreign workers earn a higher income from wine production because the relative price of cheese decreases with trade (making cheese cheaper) and the relative price of wine increases with trade.

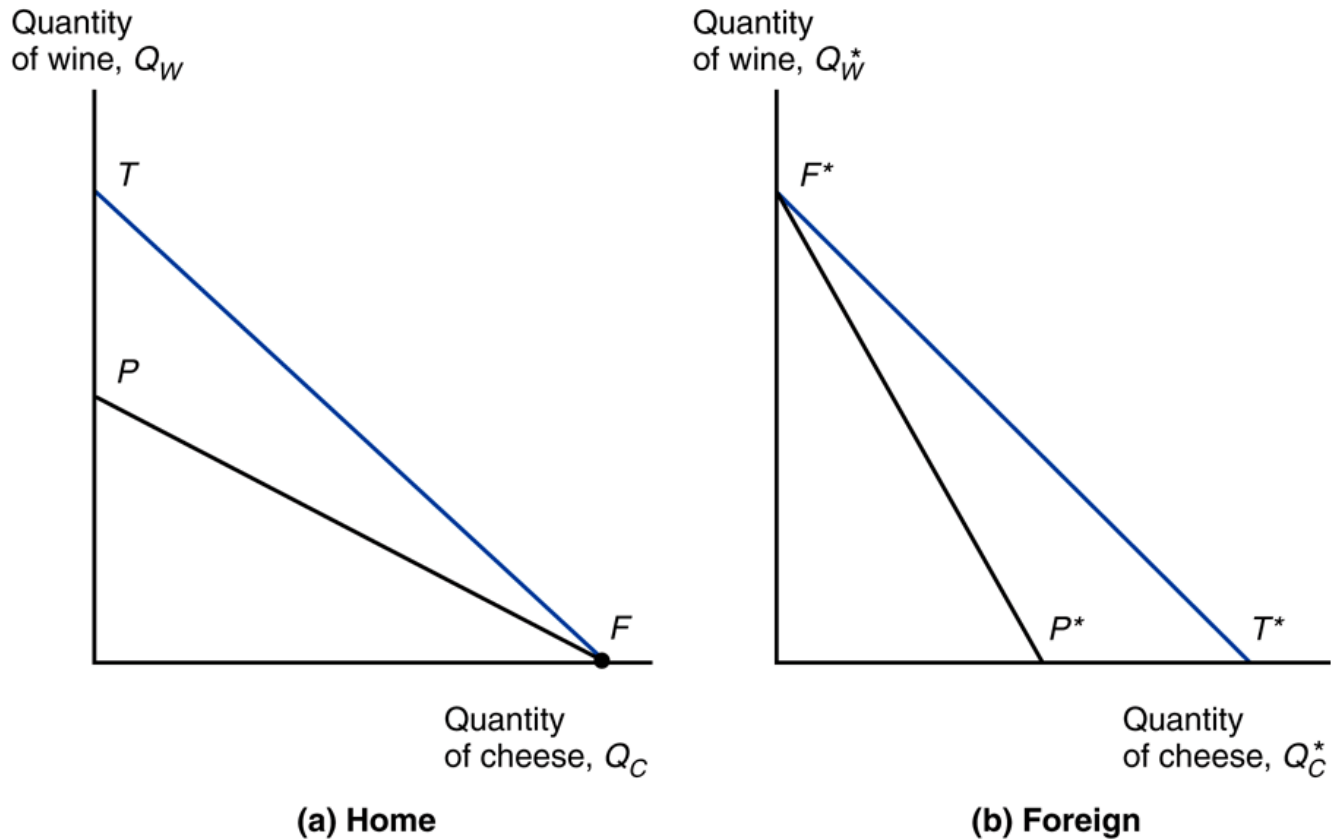
Gains From Trade (cont.)

- Think of trade as an indirect method of production that converts cheese into wine or vice versa.
- Without trade, a country has to allocate resources to produce all of the goods that it wants to consume.
- With trade, a country can specialize its production and exchange for the mix of goods that it wants to consume.

Gains From Trade (cont.)

- Consumption possibilities expand beyond the production possibility frontier when trade is allowed.
- With trade, consumption in each country is expanded because world production is expanded when each country specializes in producing the good in which it has a comparative advantage.

Fig. 3-4: Trade Expands Consumption Possibilities



A Numerical Example

Unit labor requirements for home and foreign countries

	Cheese	Wine
Home	$a_{LC} = 1$ hour/lb	$a_{LW} = 2$ hours/gallon
Foreign	$a^*_{LC} = 6$ hours/lb	$a^*_{LW} = 3$ hours/gallon

- What is the home country's opportunity cost of producing cheese? $a_{LC} / a_{LW} = 1/2$, to produce one pound of cheese, stop producing $1/2$ gallon of wine.

A Numerical Example (cont.)

- The home country is more efficient in both industries, but has a comparative advantage only in cheese production.

$$1/2 = a_{LC} / a_{LW} < a^*_{LC} / a^*_{LW} = 2$$

- The foreign country is less efficient in both industries, but has a comparative advantage in wine production.

A Numerical Example (cont.)

- With trade, the equilibrium relative price of cheese to wine settles between the two opportunity costs of cheese.
- Suppose that the intersection of RS and RD occurs at $P_C/P_W = 1$ so one pound of cheese trades for one gallon of wine.
- Trade causes the relative price of cheese to rise in the home country and fall in foreign.

A Numerical Example (cont.)

- With trade, the foreign country can buy one pound of cheese for $P_C / P_W =$ one gallon of wine,
 - instead of stopping production of $a_{LC}^* / a_{LW}^* = 2$ gallons of wine to free up enough labor to produce one pound of cheese in the absence of trade.
 - Suppose $L^* = 3,000$. The foreign country can trade its 1,000 gallons maximum production of wine for 1,000 pounds of cheese, instead of the 500 pounds of cheese it could produce itself.

A Numerical Example (cont.)

- With trade, the home country can buy one gallon of wine for $P_W / P_C =$ one pound of cheese,
 - instead of stopping production of $a_{LW} / a_{LC} =$ two pounds of cheese to free up enough labor to produce one gallon of wine in the absence of trade.
- The home country can trade its 1,000 pounds maximum production of cheese for 1,000 gallons of wine, instead of the 500 gallons of wine it could produce itself.