KRUGMAN | OBSTFELD | MELITZ

INTERNATIONAL ECONOMICS

THEORY & POLICY

TENTH EDITION

Chapter 3

Labor Productivity and Comparative Advantage: The Ricardian Model

Preview

- Opportunity costs and comparative advantage
- A one-factor Ricardian model
- Production possibilities
- Gains from trade
- Wages and trade
- Misconceptions about comparative advantage
- Transportation costs and non-traded goods
- Empirical evidence

Introduction

- 2 main theories of why trade occurs:

- Comparative advantage - differences across countries in labor, capital, natural resources, and technology

  - The Ricardian model (Chapter 3) examines differences in the *productivity of labor* (due to differences in *technology)* between countries.

  - The specific factors model (Chapter 4) examines the impact of specific factors on the distribution of income in an economy.

  - The Heckscher-Ohlin model (Chapter 5) examines differences in the amount of *labor, labor skills, physical capital, land, or other factors of production* between countries.

- Economies of scale (larger scale of production is more efficient)

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.

- 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.

- Trade between two countries can benefit both countries if each economy exports the goods in which it has a comparative advantage.

A One-Factor Ricardian Model

The model assumes that:

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.

4. Two goods: wine and cheese.

5. Competition allows workers to be paid a 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

- 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.

- Labor supply L indicates the total number of hours worked in the home country (a constant number).

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.

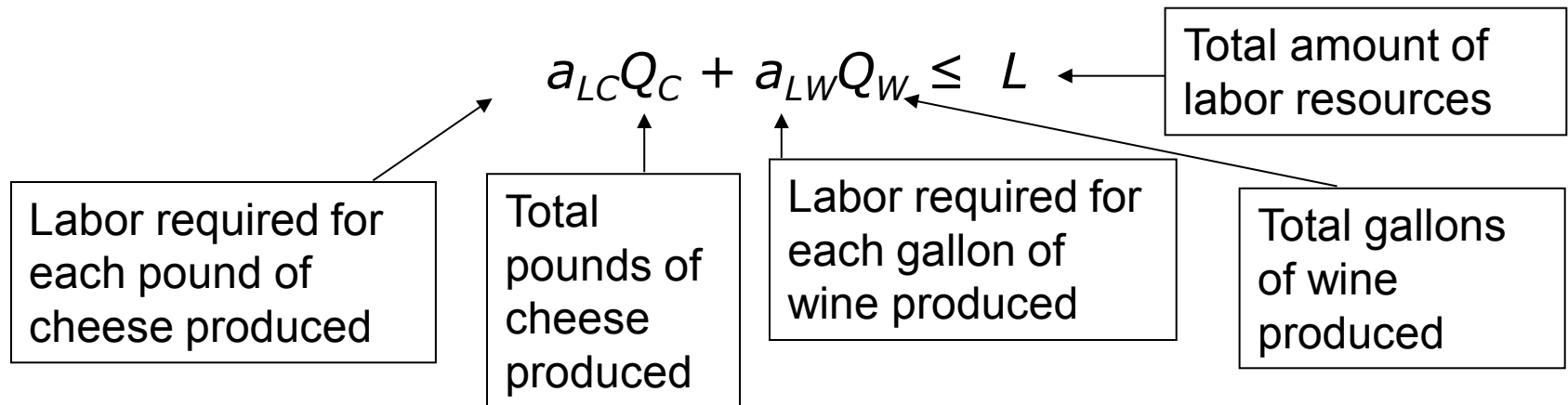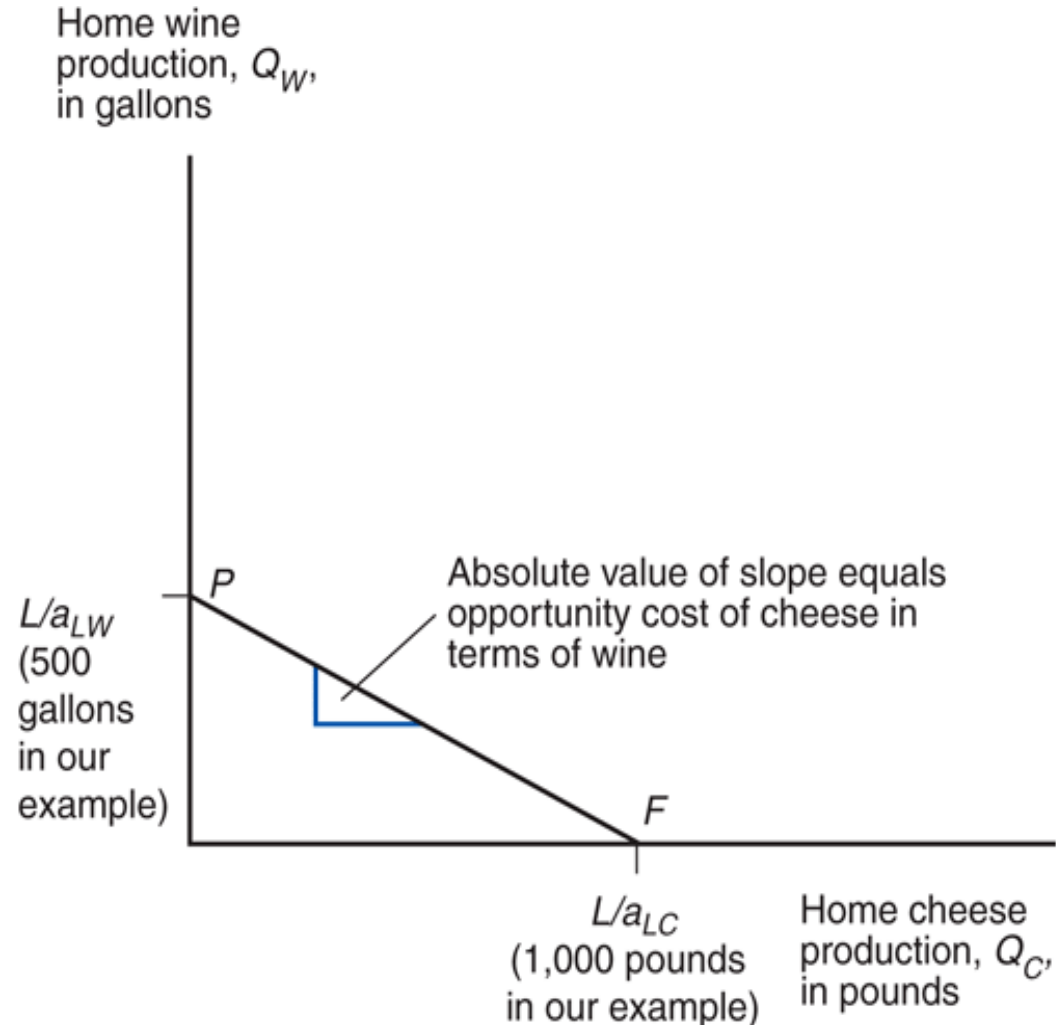- If Q_C denotes quantity of cheese and Q_W denotes quantity of wine, then the PPF of the home economy is:

$$a_{LC}Q_C + a_{LW}Q_W \leq L$$

Total amount of labor resources

Labor required for each pound of cheese produced

Total pounds of cheese produced

Labor required for each gallon of wine produced

Total gallons of wine produced

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

Home wine production, Q_W, in gallons

L/a_{LW} (500 gallons in our example)

P

Absolute value of slope equals opportunity cost of cheese in terms of wine

F

L/a_{LC} (1,000 pounds in our example)

Home cheese production, Q_C, in pounds

Suppose that the economy's labor supply is L=1000 hours; a_{LW} = 2, a_{LC} = 1.

The PPF equation $a_{LC}Q_C + a_{LW}Q_W \leq L$ becomes $Q_C + 2Q_W \leq 1000$.
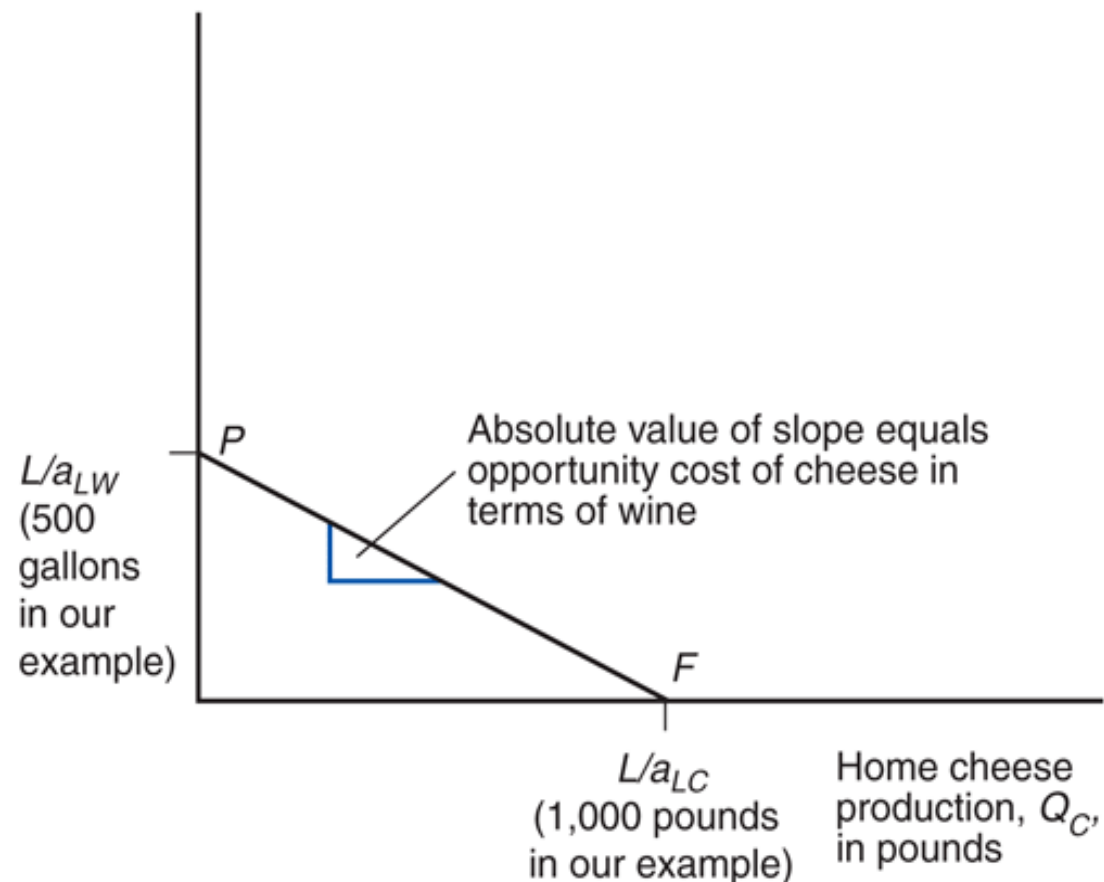
Maximum cheese production is $Q_C = L/a_{LC}$ = 1000 pounds.

Maximum wine production is $Q_W = L/a_{LW}$ = 500 gallons.

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

Home wine production, Q_W, in gallons

L/a_{LW} (500 gallons in our example)

P

Absolute value of slope equals opportunity cost of cheese in terms of wine

F

L/a_{LC} (1,000 pounds in our example)

Home cheese production, Q_C, in pounds

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} = $ ½ gallons of wine

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.

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

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}

- Workers will choose to work in the industry that pays the higher wage.

Relative Prices, Wages, and Supply

- Relation between relative price of cheese and opportunity cost of cheese:

- $P_C/P_W > a_{LC}/a_{LW}$

- Wage in cheese will exceed the wage in wine: $P_C/a_{LC} > P_W/a_{LW}$

- So workers and the economy as a whole will make only cheese .

- $P_C/P_W < a_{LC}/a_{LW}$

- Wage in cheese will be less than the wage in wine $P_C/a_{LC} < P_W/a_{LW}$.

- So workers and the economy as a whole will make only wine.

Relative Prices, Wages, and Supply

- If the country wants to consume both wine and cheese (in the absence of international trade), relative prices must adjust so that wages are equal in both industries.

  - If $P_C/a_{LC} = P_W/a_{LW}$ workers will not care whether they work 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: $P_C/P_W = a_{LC}/a_{LW}$

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

Foreign wine production, Q^*_W, in gallons

L^*/a^*_{LW} — F^*

P^*

L^*/a^*_{LC}

Foreign cheese production, Q^*_C, in pounds
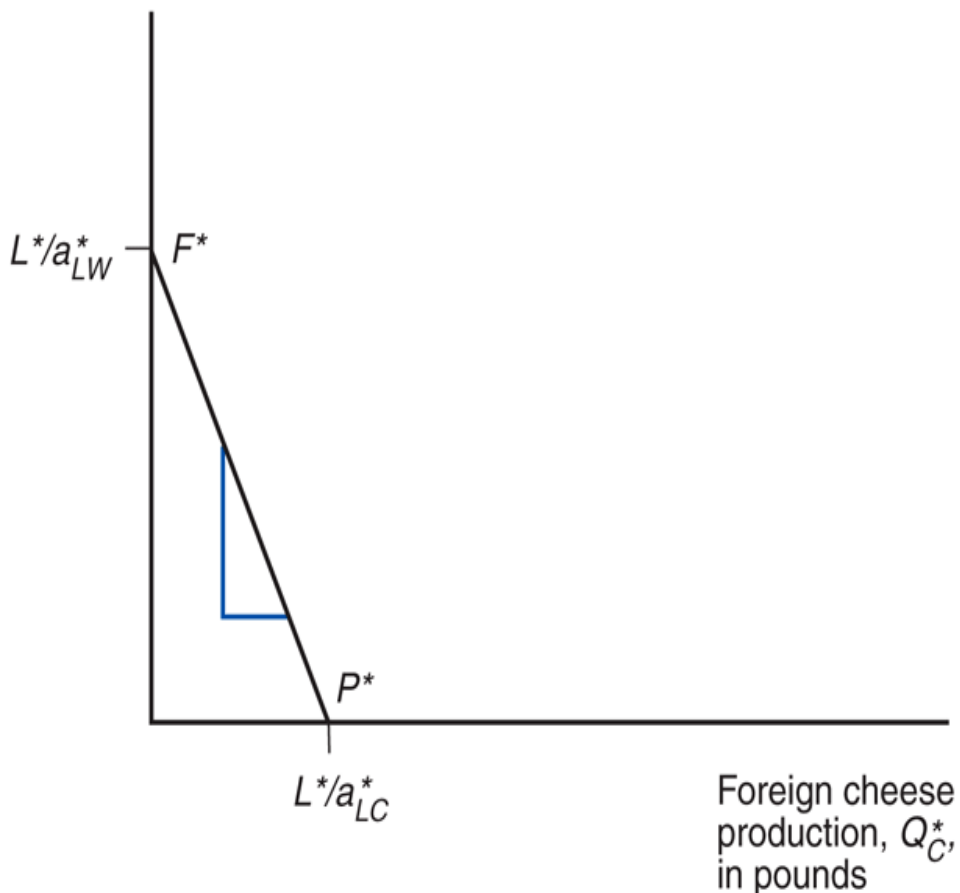
Suppose that the home country has a comparative advantage in cheese production: its opportunity cost of producing cheese is lower than in the foreign country.

$1/2 = a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW} = 6/3$

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.

Trade in the Ricardian Model

- 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?

- To see how all countries can benefit from trade, need to find relative prices when trade exists.

Trade in the Ricardian Model

- 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 of cheese depends on:
  - relative price of cheese: P_C/P_W
  - opportunity cost of cheese at home country: a_{LC}/a_{LW}
 - opportunity cost of cheese at foreign country: $a^*_{LC}/a^*_{LW,}$

World relative supply

- $P_C/P_W < a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$: no cheese would be produced, domestic and foreign workers would be willing to produce only wine (where wage is higher).

- $P_C/P_W = a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$: domestic workers are indifferent about producing wine or cheese (wages are the same), foreign workers produce only wine.

- $a_{LC}/a_{LW} < P_c/P_W < a^*_{LC}/a^*_{LW}$: domestic workers produce only cheese (where their wages are higher), foreign workers still produce only wine (where their wages are higher).

- $a_{LC}/a_{LW} < P_C/P_W = a^*_{LC}/a^*_{LW}$: foreign workers are indifferent about producing wine or cheese (wages are the same), domestic workers produce only cheese.

- $a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW} < P_C/P_W$: no wine is produced, home and foreign workers are willing to produce only cheese (where wage is higher).

Fig. 3-3: World Relative Supply and Demand
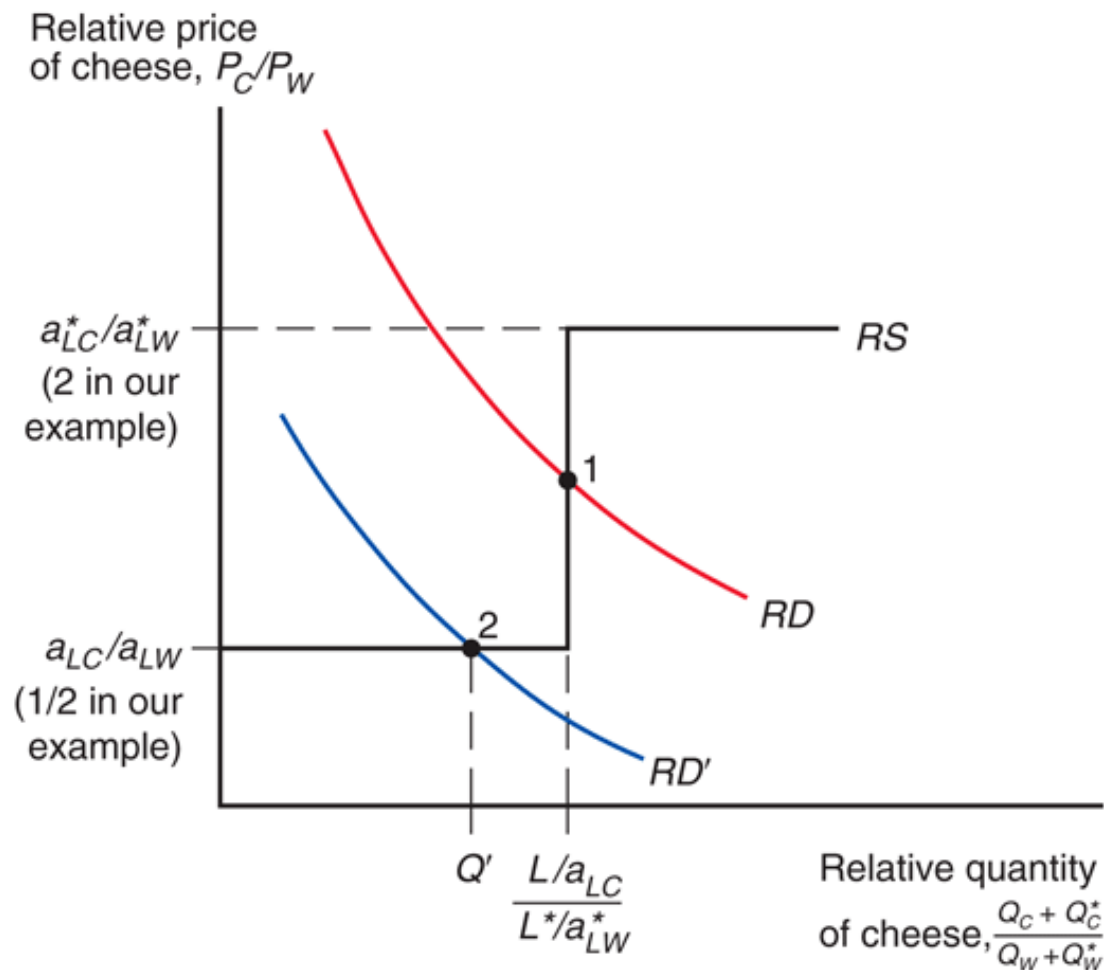
Relative demand of cheese is the quantity of cheese demanded in all countries relative to the quantity of wine demanded in all countries.

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.

Gains from Trade

- Gains from trade come from specializing in the type of production in which a country has a comparative advantage.

  – 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 wine increases with trade.

- 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. In this case, consumption is constrained by PPF.

  – With trade, a country can specialize its production and exchange for the mix of goods that it wants to consume.

Fig. 3-4: Trade Expands Consumption Possibilities

(a) Home
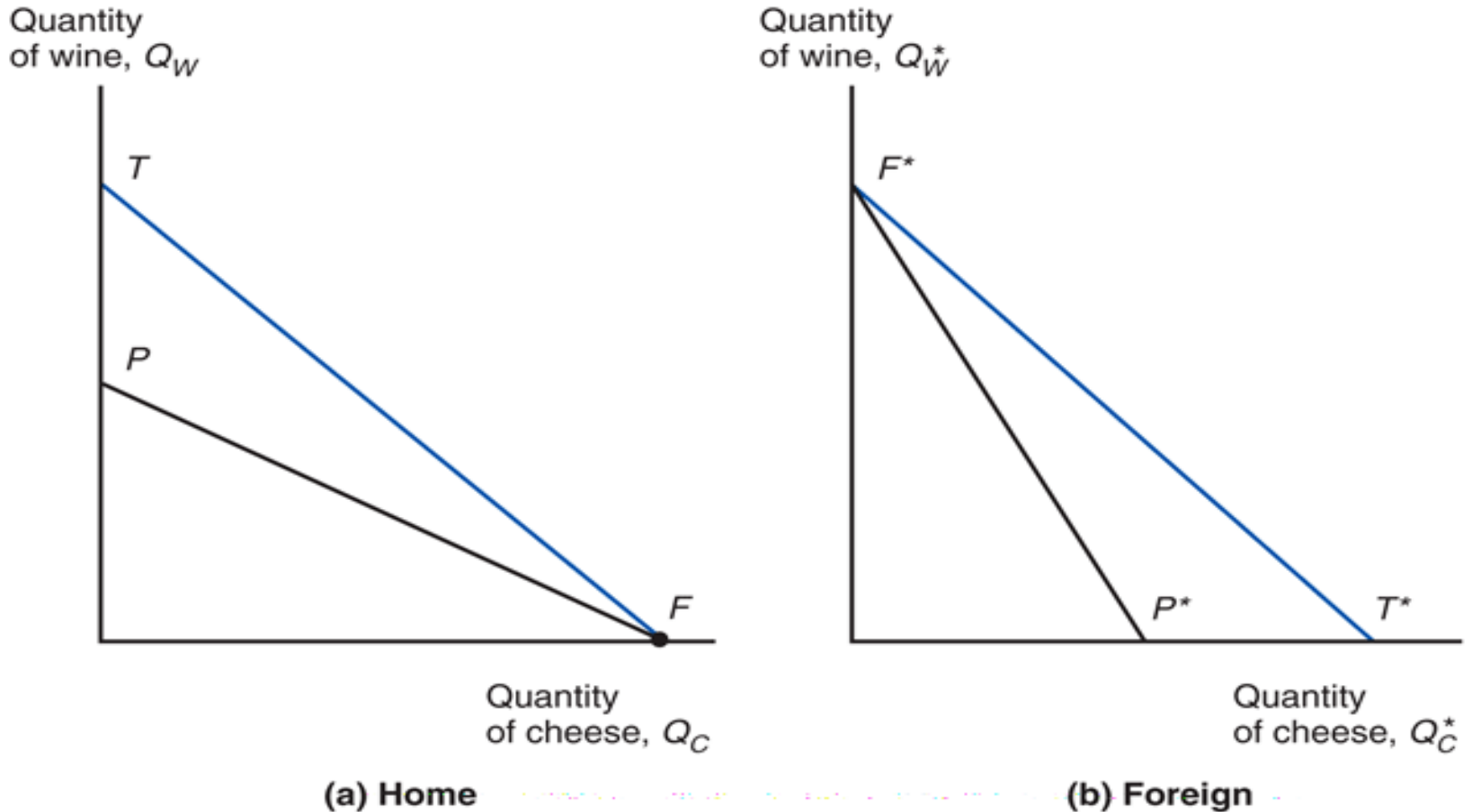
(b) Foreign

Consumption possibilities expand beyond the production possibility frontier when trade is allowed.

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} = ½, to produce one pound of cheese, stop producing ½ gallon of wine.

A Numerical Example

- The home country has an absolute advantage in both goods, but has a comparative advantage only in cheese production: $1/2 = a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW} = 2$

- The foreign country has no absolute advantage, but has a comparative advantage in wine production.

- With trade, the equilibrium relative price of cheese to wine settles between the two opportunity costs of cheese, i.e. between ½ and 2.

  – Suppose that the intersection of RS and RD occurs at $P_C/P_W = 1$, so 1 pound of cheese trades for 1 gallon of wine.

  – Trade causes the relative price of cheese to rise in the home country and fall in foreign.

A Numerical Example

- If the home country does not trade, they are able to produce $1/a_{LW} =$ <u>1/2 gallons of wine per hour</u>.

- If the home country does trade, they are able to produce $1/a_{LC} = 1$ pound of cheese per hour and then sell it to the foreign country for **1 gallon of wine**.

- If the foreign country does not trade, they are able to produce $1/a^*_{LC} =$ <u>1/6 pounds of cheese per hour</u>.

- If the foreign country does trade, they are able to produce $1/a^*_{LW} = 1/3$ gallons of wine per hour and then sell it to the home country for **<u>1/3 pounds of cheese</u>** .

Relative Wages

- **Relative wages** are the wages of the home country relative to the wages in the foreign country.

- Productivity (technological) differences determine relative wage differences across countries.

- The home wage relative to the foreign wage will settle in between the ratio of how much better Home is at making cheese and how much better it is at making wine compared to Foreign.

- Relative wages cause Home to have a cost advantage in only cheese and Foreign to have a cost advantage in only wine.

Relative Wages – A Numerical Example

- Suppose that P_C = $12/pound and P_W = $12/gallon.

- Since domestic workers specialize in cheese production after trade, their hourly wages will be

$$P_C/a_{LC} = \$12/1 = \$12$$

- Since foreign workers specialize in wine production after trade, their hourly wages will be

$$P_W/a^*_{LW} = \$12/3 = \$4$$

- The relative wage of domestic workers is therefore

$$\$12/\$4 = 3$$

Relative Wages – A Numerical Example

- The relative wage lies between the ratio of the productivities in each industry.

  - The home country is 6/1 = 6 times as productive in cheese production, but only 3/2 = 1.5 times as productive in wine production.

  - The home country has a wage 3 times higher than the foreign country.

- These relationships imply that both countries have a *cost advantage* in production.

  - High wages can be offset by high productivity.

  - Low productivity can be offset by low wages.

Relative Wages – A Numerical Example

- In the home economy, producing one pound of cheese costs $12 (one worker paid $12/hr) but would have cost $24 (six paid $4/hr) in Foreign.

- In the foreign economy, producing one gallon of wine costs $12 (three workers paid $4/hr) but would have cost $24 (two paid $12/hr) in Home.

- Because foreign workers have a wage that is only 1/3 the wage of domestic workers, they are able to attain a cost advantage in wine production, despite low productivity.

- Because domestic workers have a productivity that is 6 times that of foreign workers in cheese production, they are able to attain a cost advantage in cheese production, despite high wages.
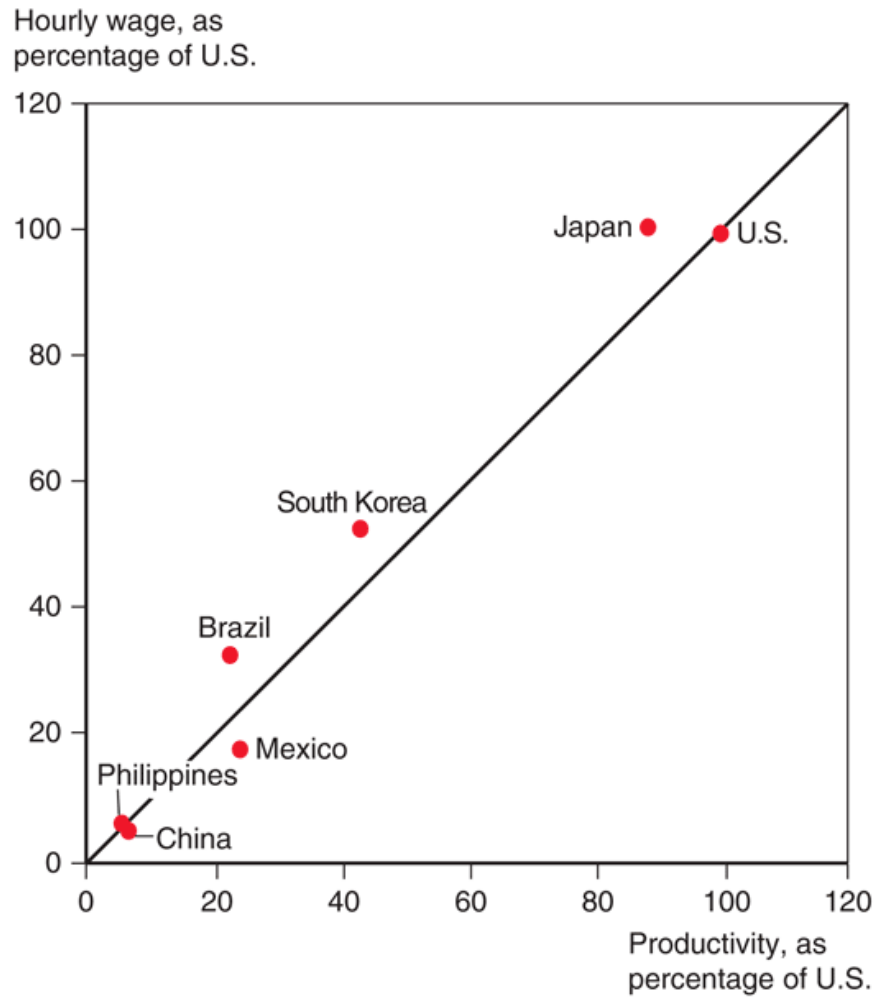
Do Wages Reflect Productivity?

- In Ricardian model, relative wages reflect relative productivities of the countries.

- Is it a realistic prediction?

- Evidence shows that low wages are associated with low productivity.

  - Wage of most countries relative to the U.S. is similar to their productivity relative to the U.S.

Productivity and Wages

Hourly wage, as percentage of U.S.

Productivity, as percentage of U.S.

Source: International Monetary Fund, Bureau of Labor Statistics, and The Conference Board.

Do Wages Reflect Productivity?

- Other evidence shows that wages rise as productivity rises.

  - As recently as 1975, wages in South Korea were only 5% of those of the United States.

  - As South Korea's labor productivity rose (to about half of the U.S. level by 2007), so did its wages.

Case Study: Babe Ruth and His Comparative Advantage

- Babe Ruth – the most famous baseball batter ever
    - Only true fans know that he was also one of the greatest pitchers of all times
    - His pitching record from 1918 in the number scoreless innings stood for 43 years!
    - Even though he had absolute advantage in both activities, his comparative advantage was in batting.
    - After pitching the hand must rest, so as a pitcher he could not bat so often.

- Boston Red Sox and consequently NY Yankees realized it and from 1919 he did not pitch anymore in order to concentrate on batting.
    - In 1920 (NYY): 54 homeruns and a slugging record (bases divided by at bats) that remains untouched to this day.

Case Study: The Losses from Nontrade

- Our discussion of the gains from trade took the form of a "thought experiment" in which we compare situations with trade and without trade.

  - In reality, countries do not suddenly go from no trade to free trade or vice versa.

- Napoleonic Wars offer a "natural experiment"

  - Britain imposed a trade blockade on France and sometimes they seized U.S. merchant ship. In reaction to this, U.S. declared a complete ban on overseas shipping (for 14 months).

  - The ban was very effective in the sense that it almost completely eliminated the trade between USA and the rest of the world.

  - Irwin (2005) estimates that the real income in the United States may have fallen by about 8 percent as a result of the embargo.

Misconceptions about Comparative Advantage

1. Free trade is beneficial only if a country is more productive than foreign countries.

   – But even an unproductive country benefits from free trade by avoiding the high costs for goods that it would otherwise have to produce domestically.

   – High costs derive from inefficient use of resources.

   – The benefits of free trade do not depend on absolute advantage, rather they depend on comparative advantage: specializing in industries that use resources most efficiently.

Misconceptions about Comparative Advantage

2. Free trade with countries that pay low wages hurts high wage countries.

   - While trade may reduce wages for *some* workers, thereby affecting the distribution of income within a country, trade benefits consumers and other workers.

   - Consumers benefit because they can purchase goods more cheaply.

   - Producers/workers benefit by earning a higher income in the industries that use resources more efficiently, allowing them to earn higher prices and wages.

Misconceptions about Comparative Advantage

3. Free trade exploits less productive countries whose workers make low wages.

   – While labor standards in some countries are less than exemplary compared to Western standards, they are so with or without trade.

   – Are high wages and safe labor practices alternatives to trade? Deeper poverty and exploitation may result without export production.

   – Consumers benefit from free trade by having access to cheaply (efficiently) produced goods.

   – Producers/workers benefit from having higher profits/wages—higher compared to the alternative.

Comparative Advantage with Many Goods

- Suppose there are *N* goods produced, indexed by $i = 1,2,...N.$

- The home country's unit labor requirement for good *i* is a_{Li}, and the corresponding foreign unit labor requirement is a^*_{Li}.

- Goods will be produced wherever cheapest to produce them.

- Let *w* represent the wage rate in the home country and w^* represent the wage rate in the foreign country.

  – If $wa_{L1} < w^*a^*_{L1}$ then only the home country will produce good 1, since total wage payments are less there.

  – Or equivalently, if $a^*_{L1}/a_{L1} > w/w^*$, if the relative productivity of a country in producing a good is higher than the relative wage, then the good will be produced in that country.

Table 3-2: Home and Foreign Unit Labor Requirements

Good	Home Unit Labor Requirement a_{Li}	Foreign Unit Labor Requirement (a_{Li}^*)	Relative Home Productivity Advantage (a_{Li}^*/a_{Li})
Apples	1	10	10
Bananas	5	40	8
Caviar	3	12	4
Dates	6	12	2
Enchiladas	12	9	0.75

Suppose there are 5 goods produced in the world: apples, bananas, caviar, dates, and enchiladas.

If $w/w^* = 3$, the home country will produce apples, bananas, and caviar, while the foreign country will produce dates and enchiladas.

The relative productivities of the home country in producing apples, bananas, and caviar are higher than the relative wage.

Comparative Advantage with Many Goods

- If each country specializes in goods that use resources productively and trades the products for those that it wants to consume, then each benefits.

  - If a country tries to produce all goods for itself, resources are "wasted".

- The home country has high productivity in apples, bananas, and caviar that give it a cost advantage, despite its high wage.

- The foreign country has low wages that give it a cost advantage, despite its low productivity in date production.

Fig. 3-5: Determination of Relative Wages

Relative wages are determined by the relative supply of and relative (derived) demand for labor.

The relative (derived) demand for home labor services falls when w/w^* rises.

As domestic labor services become more expensive relative to foreign labor services, goods produced in the home country become more expensive, and demand for these goods and the labor services to produce them falls.

It is supposed that relative supply of labor is independent of w/w^* and is fixed at an amount determined by the populations in the home and foreign countries.
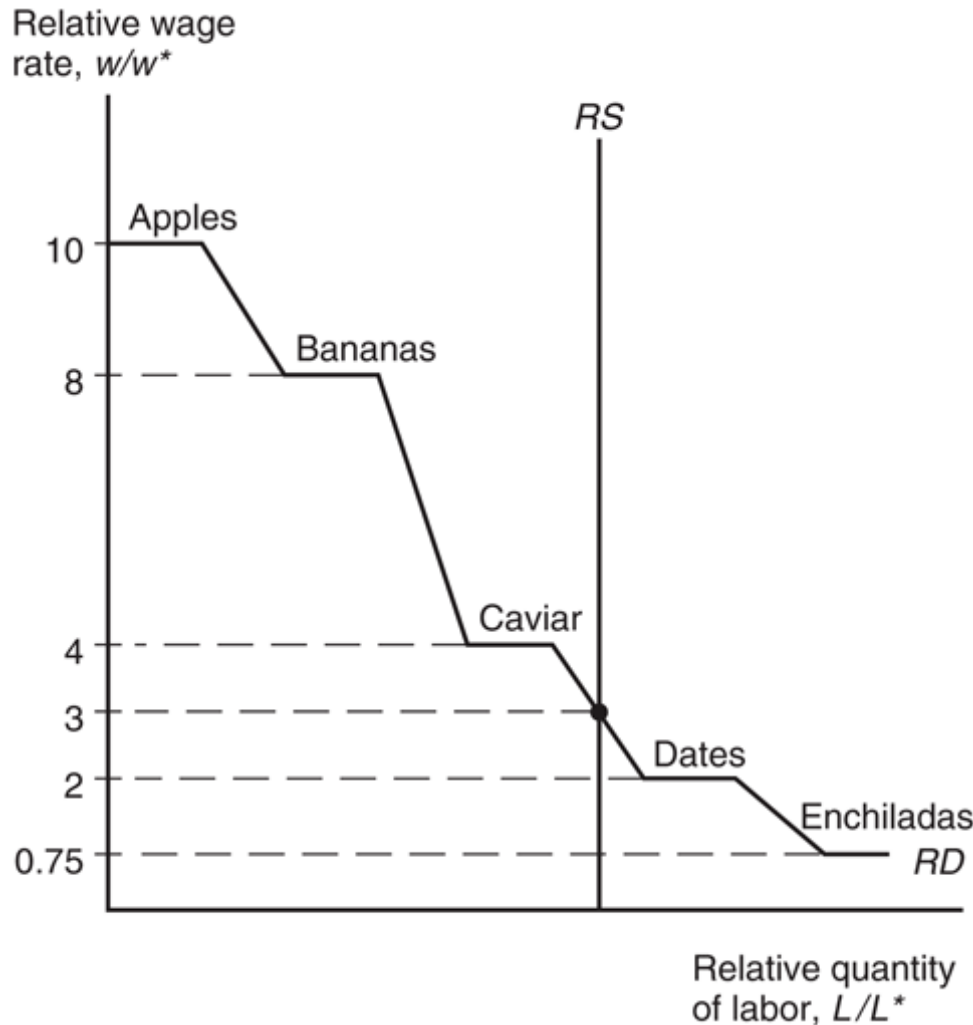
Fig. 3-5: Determination of Relative Wages

Suppose w/w^* increases from 3 to 3.99:

The home country would produce apples, bananas, and caviar, but the demand for these goods and the labor to produce them would fall as the relative wage rises.

Suppose w/w^* increases from 3.99 to 4.01:

Caviar is now too expensive to produce in the home country, so the caviar industry moves to the foreign country, causing an abrupt drop in the demand for domestic labor services.
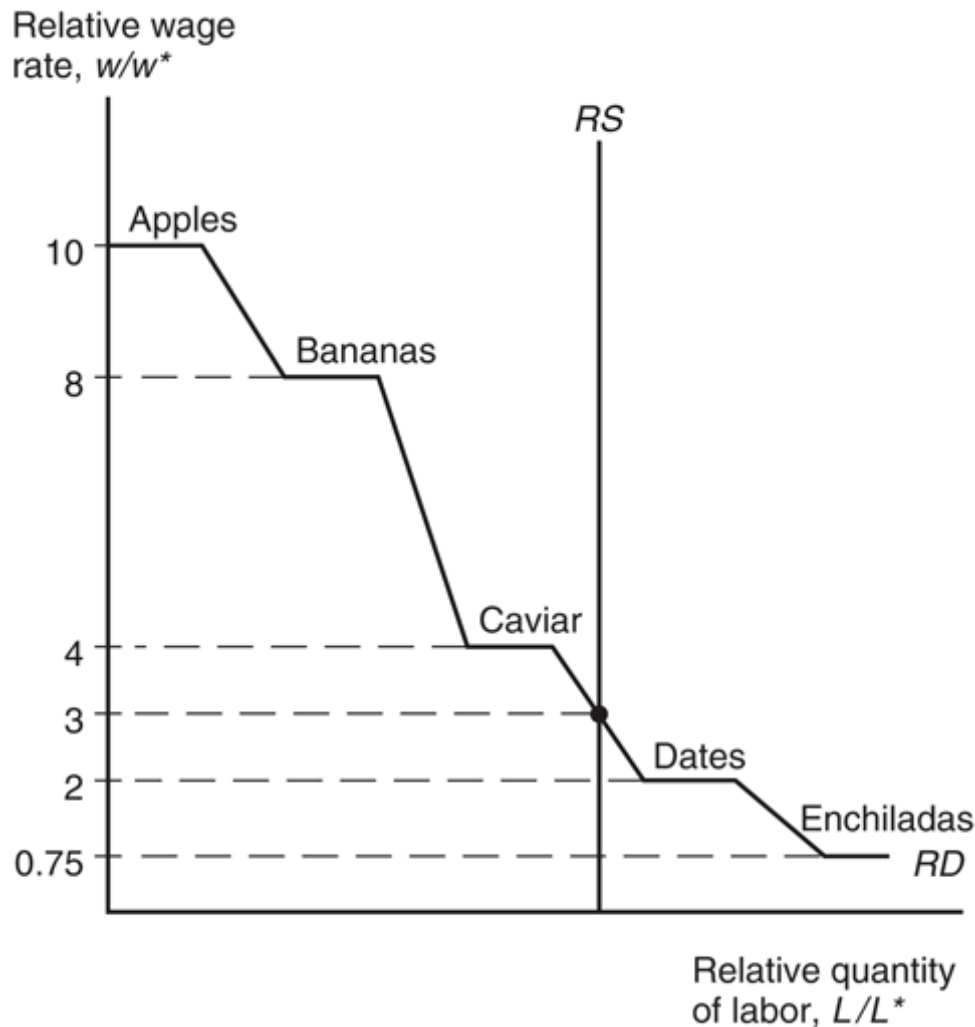
Transportation Costs and Non-traded Goods

- The Ricardian model predicts that countries completely specialize in production.

- But this rarely happens for three main reasons:
    1. More than one factor of production reduces the tendency of specialization (Chapters 4-5).
    2. Trade policy and protectionism (Chapters 9–12).
    3. Transportation costs reduce or prevent trade, which may cause each country to produce the same good or service.

- Nontraded goods and services (ex., haircuts and auto repairs) exist due to high transport costs.

    - Countries tend to spend a large fraction of national income on nontraded goods and services.

Empirical Evidence

- Do countries export those goods in which their productivity is relatively high?

- Absolutely YES!

- MacDougall (1951) examined the relation between the ratio of U.S. to British exports and the the ratio of U.S. to British labor productivity in 26 manufacturing industries.

- At this time the U.S. had an absolute advantage in *all* 26 industries, yet the ratio of exports was low in the relatively least productive sectors of the U.S.
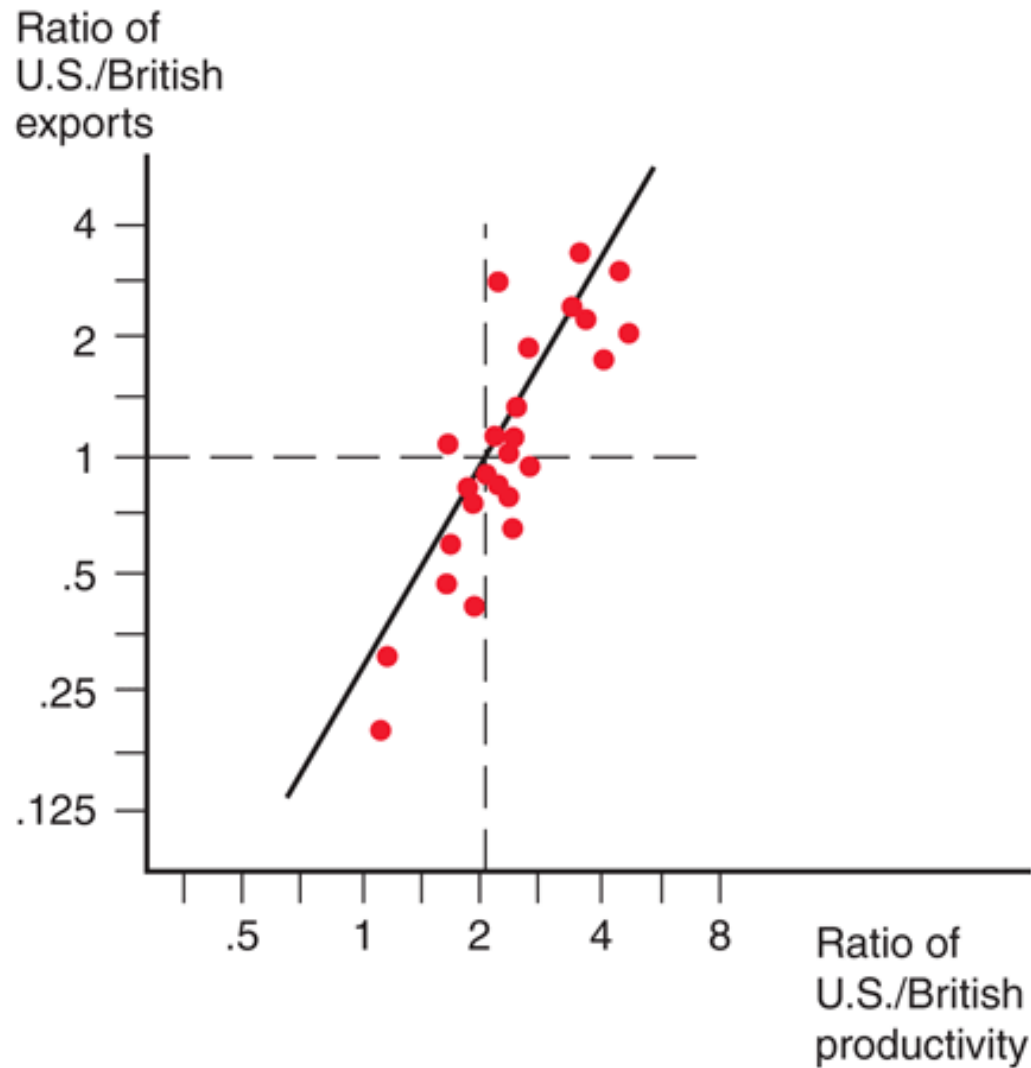
Fig. 3-6: Productivity and Exports

Table 3-3a: Germany versus China, 1995

	Chinese output per worker as % of Germany	Total Chinese output as % of Germany
All manufacturing	5.2	71.6
Apparel	19.7	802.2

Source: Ren Ruoen and Bai Manying, "China's Manufacturing Industry in an International Perspective: A China-Germany Comparison," *Economie internationale,* no. 92–2002/4, pp. 103–130.

Table 3-3b: Bangladesh versus China, 2011

	Bangladeshi Output per Worker as % of China	Bangladeshi exports as % of China
All industries	28.5	1.0
Apparel	77	15.5

Source: McKinsey and Company, "Bangladesh's ready-made garments industry: The challenge of growth," 2012; UN Monthly Bulletin of Statistics.

A very poor country like Bangladesh can have comparative advantage in clothing despite being less productive in clothing than other countries such as China because it is even less productive compared to China in other sectors.

Productivity (output per worker) in Bangladesh is only 28 percent of China's on average.

In apparel, productivity in Bangladesh was about 77 percent of China's, creating strong comparative advantage in apparel for Bangladesh.

Empirical Evidence

- The Ricardian model does not provide fully adequate description of the causes and consequences of world trade, because it is too simple and stylized.

  – Only one factor of production and the economies differ only in the labor productivity.

- However, the main implications of the Ricardian model are well supported by empirical evidence:

  – productivity differences play an important role in international trade

  – comparative advantage (not absolute advantage) matters for trade

Summary

1. Differences in the productivity of labor across countries generate comparative advantage.

2. A country has a comparative advantage in producing a good when its opportunity cost of producing that good is lower than in other countries.

3. Countries export goods in which they have a comparative advantage - high productivity *or* low wages give countries a cost advantage.

Summary

4. With trade, the relative price settles in between what the relative prices were in each country before trade.

5. Trade benefits all countries due to the relative price of the exported good rising: income for workers who produce exports rises, and imported goods become less expensive.

6. Empirical evidence supports trade based on comparative advantage, although transportation costs and other factors prevent complete specialization in production.