

Chapter 3

Labor Productivity and Comparative Advantage: The Ricardian Model

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Learning goals

Explain how the *Ricardian model* works and how it illustrates the principle of *comparative advantage*

Demonstrate *gains from trade*

Describe the empirical evidence that wages reflect productivity and trade patterns reflect relative productivity.

Introduction

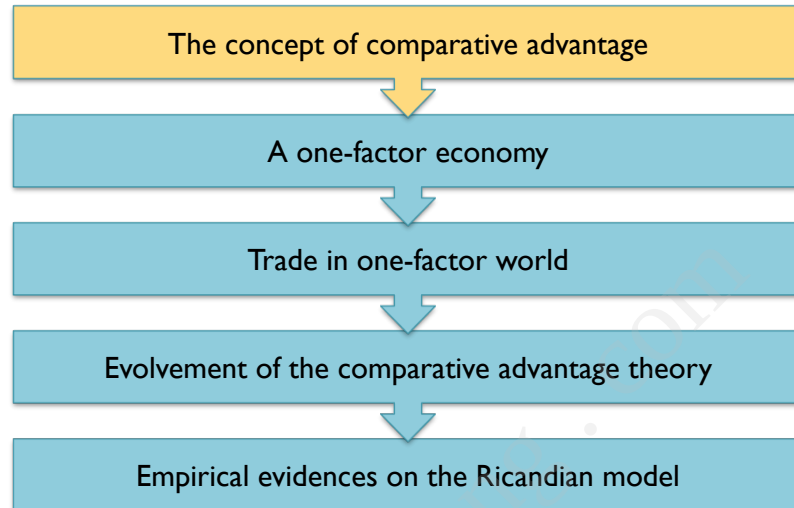
- Theories of why trade occurs can be grouped into three categories:
 - Market size and distance between markets determine how much countries buy and sell (Gravity model).
 - Differences in labor, physical capital, natural resources and technology create productive advantages for countries (Countries are different).
 - Economies of scale (larger is more efficient) create productive advantages for countries.
- => Practical international trade patterns reflect the interaction of all of these motives.

Introduction (cont.)

- Theory of Group 2
 - The Ricardian model (chapter 3) says **differences in productivity of labor** between countries cause productive differences, leading to gains from trade.
 - Differences in productivity are usually explained by differences in *technology*.
 - The Heckscher-Ohlin model (chapter 4) says **differences in labor, labor skills, physical capital and land (resource endowment)** between countries cause productive differences, leading to gains from trade.

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Preview



The concept of absolute advantage

- Adam Smith - Absolute advantage theory
 - Trade between countries is based upon absolute advantage
 - Absolute advantage: produce **more efficiently**

	US	UK
Wheat (bushels/hour of labor)	6	1
Cloth (meters/hour of labor)	4	5

- The US: absolute advantage in wheat production and The UK in cloth production
 - Two countries exchange 6W:6C
 - The US would be better off by 2m of cloth
 - The UK would be ahead by 24m of cloth
- => Both nations gain, but the UK gains more.

Comparative Advantage and Opportunity Cost

- The Ricardian model uses the concepts of *opportunity cost* and *comparative advantage* to explain why it is the interests of countries to trade.
 - A country has a **comparative advantage** in producing a good **if the opportunity cost of producing that good is lower** in the country than it is in other countries.
- The difference in opportunity cost offers the possibility of a mutually beneficial rearrangement of world production and trade
- *Trade between two countries can benefit both countries if each country exports the goods in which it has a comparative advantage*

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Comparative Advantage and Opportunity Cost (cont.)

- Example of two countries (US and Colombia) , two commodities (roses and computers) and, one factor model (labor).

Nations	Roses (million)	Computers (thousand)
US	10	100
Colombia	10	30

- **The US** has a lower opportunity cost and therefore a comparative advantage in producing **computers**.
- **Colombia** has a lower opportunity cost and therefore a comparative advantage in producing **roses**.

Comparative Advantage and Trade

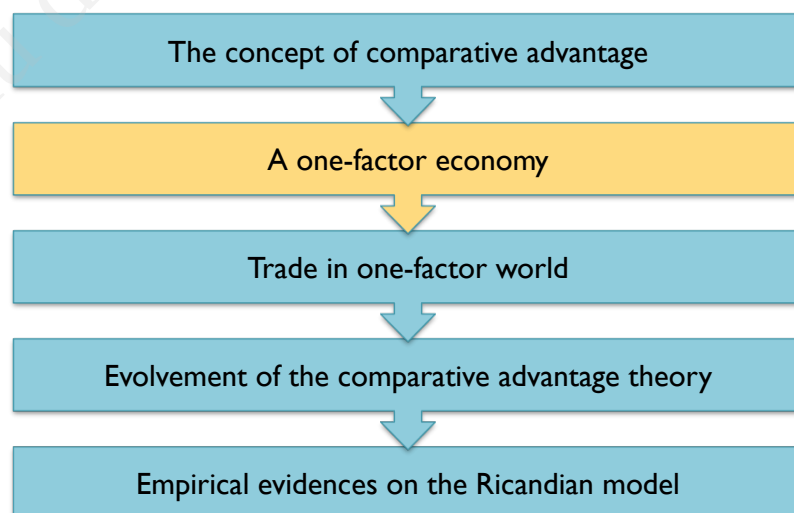
	Millions of Roses	Thousands of Computers
U.S.	-10	+100
Colombia	+10	-30
Total	0	+70

The US gives up producing roses and only produce computers

Colombia gives up producing computers and only produce roses

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Preview



A One-factor economy

- Production possibilities
- Relative prices and Supply
- Production, price and wage

Assumptions

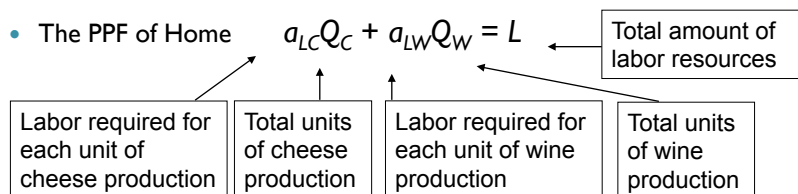
1. Only two countries are modeled: Home or Domestic (H) and Foreign (F).
2. Only two goods are important for production and consumption: wine (W) and cheese (C).
3. Labor is the only production factor (L)
4. Labor productivity varies across countries, usually due to differences in technology, but labor productivity in each country is constant across time.
5. The supply of labor in each country is constant.
6. Labor is fully employed and mobile between industries.
7. Competition allows laborers to be paid a “competitive” wage, a function of their productivity and the price of the good that they can sell, and allows laborers to work in the industry that pays the highest wage.

Unit labor requirement

- **An unit labor requirement:** the constant number of hours of labor required to produce one unit of output.
 - a_{LW} - a_{LW}^* : the unit labor requirement for wine in Home and Foreign.
 - a_{LC} - a_{LC}^* : the unit labor requirement for cheese in Home and Foreign.
- A high unit labor requirement means low labor productivity.

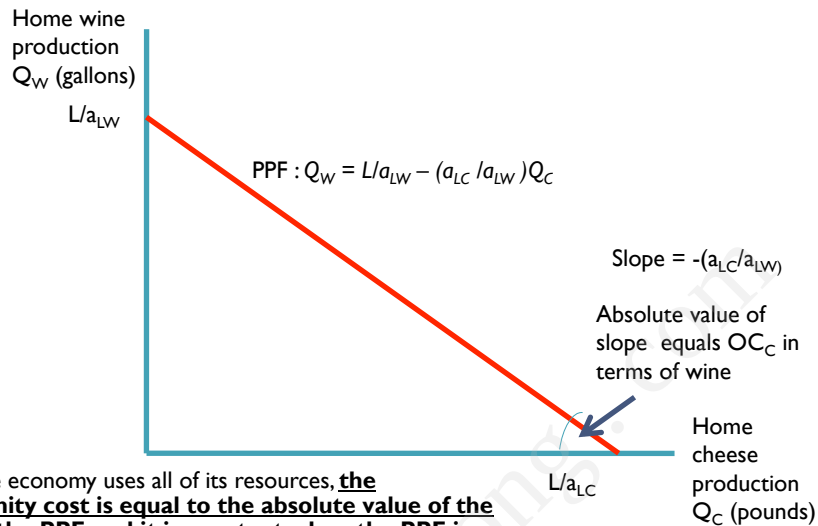
Production Possibilities

- The **production possibility frontier** (PPF) of an economy shows the *maximum* amount of goods that can be produced for a fixed amount of resources.
- One factor: PPF is a straight line
- The total number of labor hours worked in Home: L
- Q_C : the quantity of cheese produced in Home
- Q_W : the quantity of wine produced in Home
- The PPF of Home $a_{LC}Q_C + a_{LW}Q_W = L$



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

Production Possibilities (cont.)



When the economy uses all of its resources, **the opportunity cost is equal to the absolute value of the slope of the PPF, and it is constant when the PPF is a straight line.**

A numerical example

	Cheese	Wine
Home	$a_{LC} = 1 \text{ hour/kg}$	$a_{LW} = 2 \text{ hours/l}$
Foreign	$a_{LC}^* = 6 \text{ hours/kg}$	$a_{LW}^* = 3 \text{ hours/l}$

- Develop functions of PPFs of Home and Foreign.
- Sketch PPF of each nation
- Which country has a comparative advantage in cheese production?

Relative Prices and Supply

- PPF: describes what an economy **can produce**
 $a_{LC}Q_C + a_{LW}Q_W \leq L$
- To determine what the economy **does produce**,
 - Must determine the relative price (the price of one good in terms of the other) of the economy's two goods
 - Must determine wages

Relative Prices and Supply (cont.)

- *Hourly wages => affect what and how many to produce*
- P_C : the price of cheese
- P_W : the price of wine.
- Because of competition:
 - Hourly wages of workers = market value of products they can produce in one hour = P/a_L
 - hourly wages of cheese makers = P_C/a_{LC}
 - hourly wages of wine makers = P_W/a_{LW}
- Because workers like high wages, they will work in the industry that pays a higher hourly wage.

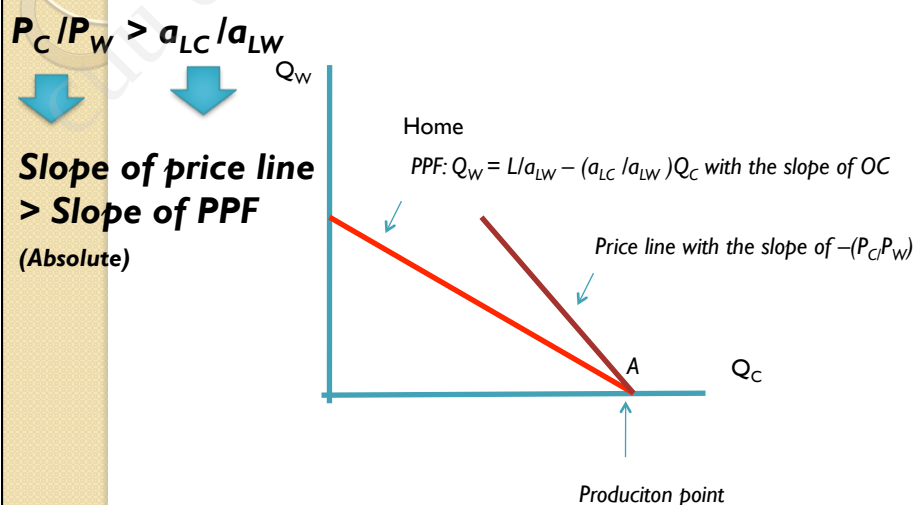
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Production, Prices and Wages

- If $P_C/a_{LC} > P_W/a_{LW}$
 - workers will make only cheese.
 - If $P_C/P_W > a_{LC}/a_{LW} \Rightarrow$ workers will only make cheese.
 - **The economy will specialize in cheese production if the price of cheese relative to the price of wine exceeds the opportunity cost of producing cheese or if the wage in cheese industry is higher than wage in wine production.**

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Production, Prices and Wages (cont.)



Production, Prices and Wages (cont.)

- If $P_C/a_{LC} < P_W/a_{LW}$
 - workers will make only wine.
 - If $P_C/P_W < a_{LC}/a_{LW} \Rightarrow$ workers will only make wine.
 - If $P_W/P_C > a_{LW}/a_{LC} \Rightarrow$ workers will only make wine.
- **The economy will specialize in wine production if the price of wine relative to the price of cheese exceeds the opportunity cost of producing wine or the relative price of cheese is less than its opportunity costs.**

Production, Prices and Wages (cont.)

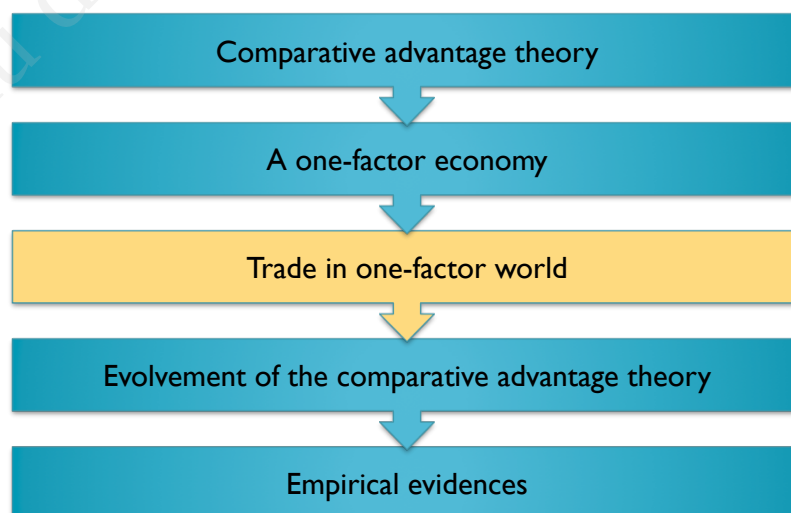
- If $P_C/a_{LC} = P_W/a_{LW}$
 - Workers will have no incentive to flock to either the cheese industry or the wine industry,
 - Thereby maintaining a positive amount of production of both goods.
 - $P_C/P_W = a_{LC}/a_{LW}$
- **Production (and consumption) of both goods occurs when relative price of a good equals the opportunity cost of producing that good.**

Wages in autarky

- In autarky, each nation should produce both products to serve consumers' demand.
- *In the absence of international trade,*
 - *The wages must be equal*
 - *The relative prices of goods are equal to their relative unit labor requirements (opportunity costs).*

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Preview



Trade in one-factor world

- When trade takes place?
- What gains trade brings about?
- How relative wage determines trade pattern?

Determining the relative price after trade

- Suppose Home has a comparative advantage in cheese production: $a_{LC}/a_{LW} < a_{LC}^*/a_{LW}^*$
- To see how all countries can benefit from trade, we calculate relative prices when trade exists. We must
 - Calculate the world relative supply (RS)
 - Calculate the world relative demand (RD)
 - Then, find the intersection between these two.

Relative Supply

- **Relative supply (RS)** of cheese: the quantity of cheese supplied by all countries relative to the quantity of wine supplied by all countries at each relative price of cheese, P_C/P_W .

$$(Q_C + Q_C^*) / (Q_W + Q_W^*)$$

- Funny shape of RS: it is a step with flat sections linked by a vertical section

Relative Supply (cont.)

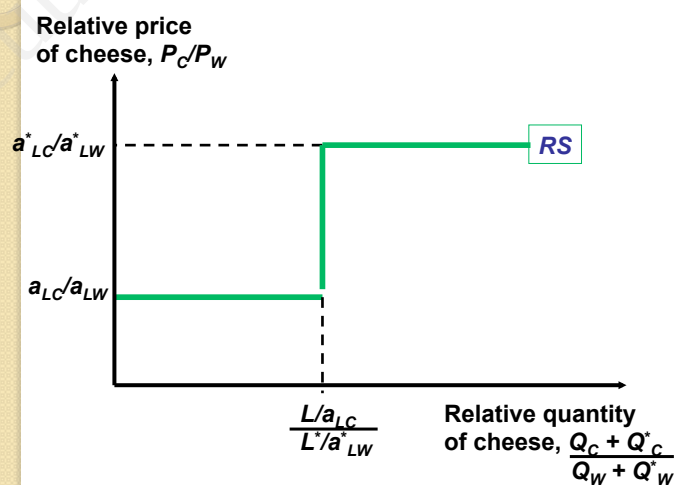
- When $P_C/P_W < a_{LC}/a_{LW} < a_{LC}^*/a_{LW}^* \Rightarrow$
 $\Rightarrow$ There is no supply of cheese.
 $\Rightarrow$ Home will specialize in wine production whenever $P_C/P_W < a_{LC}/a_{LW}$
 $\Rightarrow$ Foreign won't find it desirable to produce cheese either.
- When $P_C/P_W = a_{LC}/a_{LW}$ (relative price = OC of Cheese in Home)
- Home will be indifferent between producing wine or cheese, but Foreign will still produce only wine.
 - Relative supply of cheese of the world will be between 0 and $L/a_{LC}/L^*/a_{LW}^*$

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Relative Supply (cont.)

- When $a_{LC}/a_{LW} < P_C/P_W < a_{LC}^*/a_{LW}^*$
 - Home specializes in cheese production
 - Foreign workers will still produce only wine.
 - Relative supply of cheese is equal to $L/a_{LC}/L^*/a_{LW}^*$
- When $a_{LC}^*/a_{LW}^* = P_C/P_W$,
 - Foreign will be indifferent between producing wine or cheese
 - Home will still produce only cheese.
- There is no supply of wine if the relative price of cheese rises above a_{LC}^*/a_{LW}^*

Relative Supply (cont.)



In – class exercise: Relative Supply

- $Q_W^* = L^*/2 - Q_C^*/2$
- $Q_W = L/3 - 2Q_C$
- Suppose that $L^* = 100$ and $L = 300$.
Construct/Draw the relative supply curve of the world.

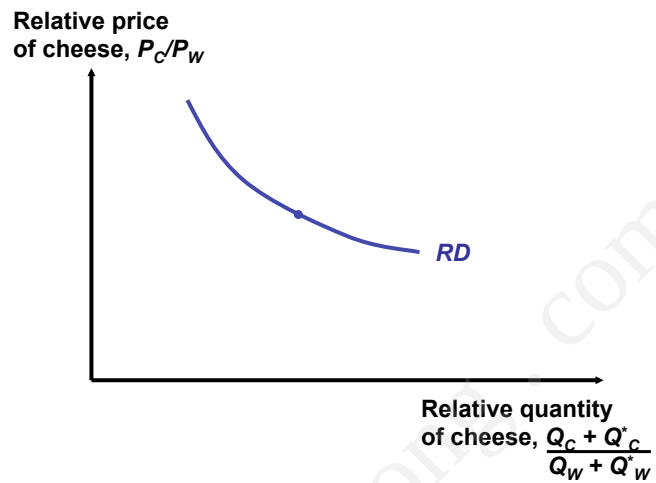
Relative Demand

- Relative demand of cheese is the quantity of cheese demanded in all countries relative to the quantity of wine demanded in all countries at each relative price of cheese, P_C/P_W .

$$(Q_C + Q_C^*)/(Q_W + Q_W^*)$$

- As the relative price of cheese rises
 - Consumers in all countries will tend to purchase less cheese and more wine
 - The relative quantity of cheese demanded falls.

Relative Demand (cont.)



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Relative Supply and Relative Demand (cont.)

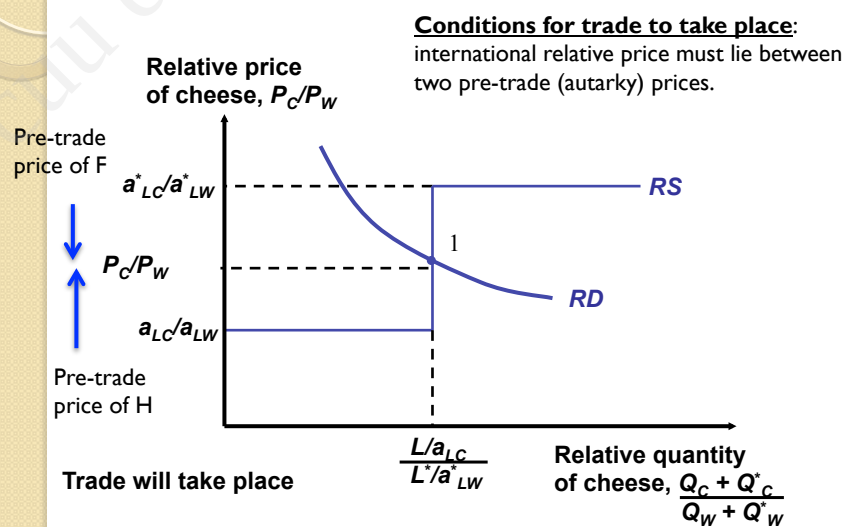
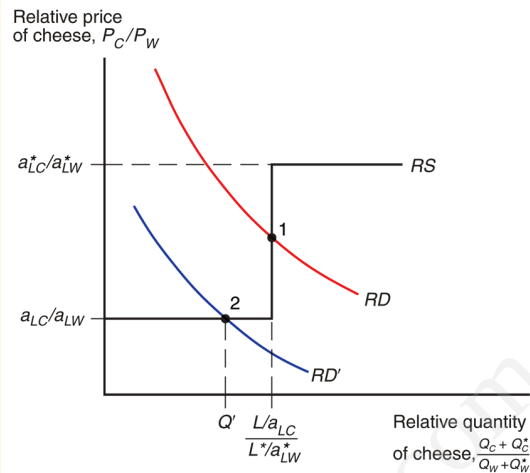


Figure 3-3

World Relative Supply and Demand

The RD and RD' curves show that the demand for cheese relative to wine is a decreasing function of the price of cheese relative to that of wine, while the RS curve shows that the supply of cheese relative to wine is an increasing function of the same relative price.



At point 2, Foreign completely specialize in wine production. Home does not specialize
 $\Rightarrow$ trade will not take place because Home is not willing to participate in trade.

Gains From Trade

- 3 ways
 - Gains from trade come from
 - specializing in production that use resources most efficiently (means producing a good in which a country has a comparative advantage).
 - using the income generated from that production to buy the goods and services that countries desire.
- $\Rightarrow$ Trade: an indirect method of production (converts cheese into wine or vice versa).

Gains From Trade (cont.)

- Benefits for workers:
 - 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.

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Gains From Trade (cont.)

- Expansion of consumption possibilities
 - Without trade, consumption is restricted to what is produced.
 - 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.

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Gains From Trade (cont.)

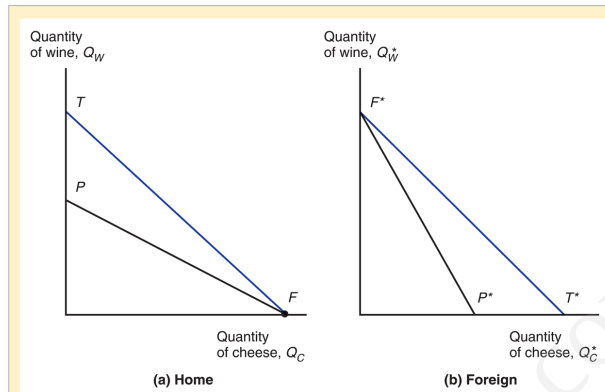


Figure 3-4

Trade Expands Consumption Possibilities

International trade allows Home and Foreign to consume anywhere within the colored lines, which lie outside the countries' production possibility frontiers.

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Relative Wages

- Political discussion of international trade: comparison of wage rates in different countries (Mexico: 2\$ per hour compared with 15\$ in the US).
- **Relative wages** are the wages of the domestic country relative to the wages in the foreign country.
- Although the Ricardian model predicts that relative prices equalize across countries after trade, it does not predict that relative wages will do the same.
- Productivity (technological) differences determine wage differences in the Ricardian model.

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Recall from the earlier numerical example

Unit labor requirements for domestic and foreign countries		
	Cheese	Wine
Domestic	$a_{LC} = 1 \text{ hour/kg}$	$a_{LW} = 2 \text{ hours/L}$
Foreign	$a_{LC}^* = 6 \text{ hours/kg}$	$a_{LW}^* = 3 \text{ hours/L}$

- $a_{LC}/a_{LW} = 1/2 < a_{LC}^*/a_{LW}^* = 2$
- Home: cheese production
- Foreign: wine production
- Identify wages of each nation and relative wages of Home to Foreign after trade? Assume $P_C = \$12/\text{kg}$ and $P_W = \$12/\text{L}$

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Relative Wages (cont.)

- Suppose that $P_C = \$12/\text{kg}$ and $P_W = \$12/\text{L}$
- After trade, domestic workers specialize in cheese production, their hourly wages will be

$$(1/a_{LC})P_C = (1/1)\$12 = \$12$$
- After trade, foreign workers specialize in wine production, their hourly wages will be

$$(1/a_{LW}^*)P_W = (1/3)\$12 = \$4$$
- The relative wage of domestic workers to foreign workers is therefore

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

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Relative Wages (cont.)

Unit labor requirements for Home and Foreign		
	Cheese	Wine
Domestic	$a_{LC} = 1$ hour/kg	$a_{LW} = 2$ hours/L
Foreign	$a^*_{LC} = 6$ hours/kg	$a^*_{LW} = 3$ hours/L

- The relative wage lies between the ratio of the productivities in each industry of two nations.
 - Home is $6/1 = 6$ times as productive as Foreign in cheese production,
 - But Home is only $3/2 = 1.5$ times as productive as Foreign in wine production.
 - Relative wage of Home is three times as high as Foreign's, lying between two productivity ratios.

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Relative Wages (cont.)

The relative wage of domestic workers is $\$12/\$4 = 3$

Home has high wages relative to Foreign

Home cheese workers have a higher productivity

Home workers have a cost advantage in cheese

The cost of high wage can be offset by high productivity

Relative Wages (cont.)

The relative wage of domestic workers is $\$12/\$4 = 3$

Foreign has lower productivity

Foreign workers have a wage that is only 1/3 of the Home workers

Foreign workers have a cost advantage (in wine production)

The cost of low productivity can be offset by low wage.

Relative Wages (cont.)

- High productivity or low wages give countries a cost advantage that allow them to produce efficiently.
- These relationships imply that both countries have a *cost advantage in production*.
 - The cost of high wages can be offset by high productivity.
 - Low productivity can be offset by low wages.

RCA (Coefficient of Revealed Comparative Advantage)

RCA

- Coefficient of Revealed Comparative Advantage (RCA)
- Represent comparative advantage or disadvantage of a certain country in a certain goods or services.
- It is based on the Ricardian comparative advantage concept

The proportion of X's export value in total export value of a nation

$$RCA_X = (E_{X1}/E_C) \div (E_{X2}/E_W)$$

The proportion of X's export value in total export value of the world

E_{X1} : Export value of commodity X of a nation (in a year)

E_C : Total export value of a nation (in a year)

E_{X2} : Export value of commodity X of the world (in a year)

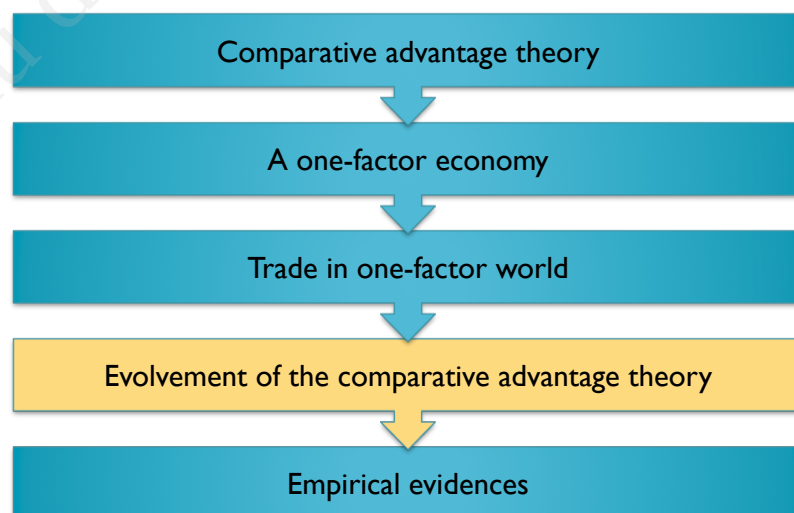
E_W : Total export value of the world (in a year)

RCA (cont.)

$$RCA_X = (E_{X1}/E_C) \div (E_{X2}/E_W)$$

- $RCA \leq 1$: the nation does not have a comparative advantage in commodity X
- $1 < RCA < 2.5$: the nation has a comparative advantage in commodity X
- $RCA \geq 2.5$: the nation has very high comparative advantage in commodity X

Preview



Setting up the model

- To move closer to reality: a model with a large number of goods.
- 2 countries: H and F; one factor: labor
- Suppose now there are N goods produced, indexed by $i = 1, 2, \dots, N$.
- The unit labor requirement for good i
 - a_{Li} : Home
 - a_{Li}^* : Foreign
- w : the wage rate in Home
- w^* : the wage rate in Foreign
- Rule: Goods will always be produced where it is cheapest to make them

Relative wages and specialization (cont.)

- If $wa_{Li} < w^*a_{Li}^*$
 - then only Home will produce good i , since total wage payments are less there.
- Or equivalently, if $a_{Li}^*/a_{Li} > w/w^*$

Relative productivity of Home in producing good i	Relative wage of Home
---	-----------------------------

 - 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 (Home).
- If $a_{Li}^*/a_{Li} < w/w^*$
 - If the relative productivity of a country in producing a good is lower than the relative wage, then the good will be produced in the other country (Foreign).

Numerical examples (cont.)

- Suppose there are 5 goods produced in the world:

TABLE 3-3 Home and Foreign Unit Labor Requirements

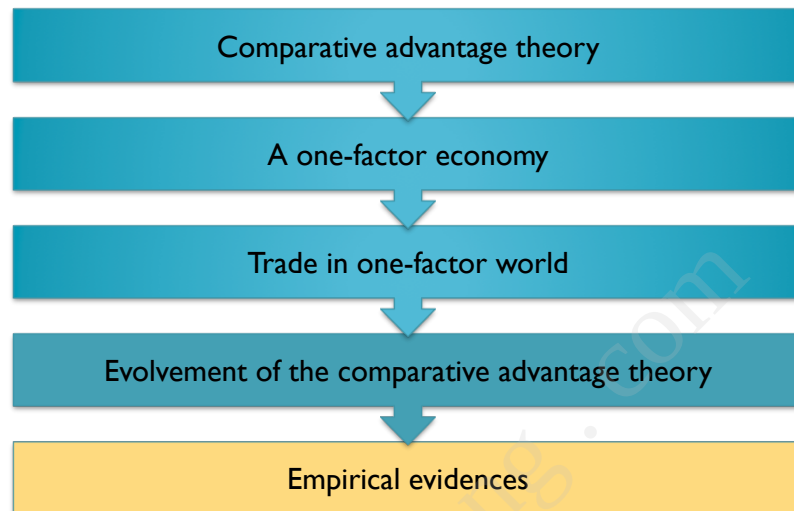
Good	Home Unit Labor Requirement (a_{Li})	Foreign Unit Labor Requirement (a_{Li}^*)	Relative Home Productivity Advantage (a_{Li}^*/a_{Li})
Apples	1	10	10
Bananas	5	40	8
Caviar	3	12	4
Dates	6	12	2
Enchiladas	12	9	0.75

If $w/w^* = 3$, Home will produce apples, bananas, and caviar, while Foreign will produce dates and enchiladas.

Pattern of trade

- The domestic 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 dates and enchiladas
- **Pattern of trade: depends on the relative wages.**
- The one-factor Ricardian Model with two nations, two commodities can be generalized and are indeed applicable to the case of many commodities.

Preview



Two faulty premises of comparative advantage theory

- Labor is not mobile between countries
 - Ricardo's entire argument—the theory of comparative advantage, global free trade itself—is **premised on the belief that most people love their country more than money**
 - However, “people are greedy” and “greed is good” (Gordon Gekoo)
- => Challenging comparative advantage model.

Two faulty premises of comparative advantage theory (cont.)

- Capital is not mobile and therefore offshoring was impossible.
 - This premises was largely true in Ricardo's time:
 - international shipping was relatively expensive
 - it was illegal to export machinery, or industrial plans, out of Britain.
 - Furthermore, Britain imposed a 50% tariff on all manufactured goods during the Industrial Revolution

Some misleading predictions of the Ricardian Model

- Predict an extreme degree of specialization (complete specialization)
- Assume away effects of international trade on the distribution of income within countries
- Allow no role for differences in resources among countries as a cause of trade
- Neglect the possible role of economies of scale as a cause of trade
- However: basic prediction that countries tend to export those goods in which their productivity is relative high has been strongly confirmed.

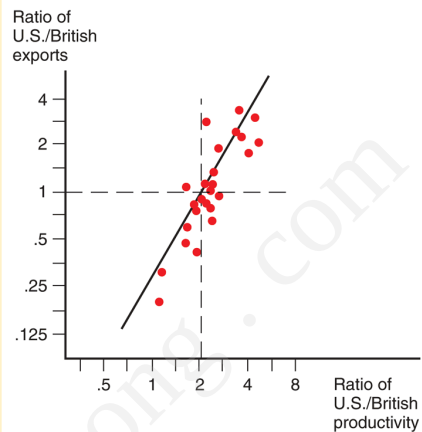
Do nations export products those goods in which their productivity is relative high ?

- YES

Figure 3-6

Productivity and Exports

A comparative study showed that U.S. exports were high relative to British exports in industries in which the United States had high relative labor productivity. Each dot represents a different industry.



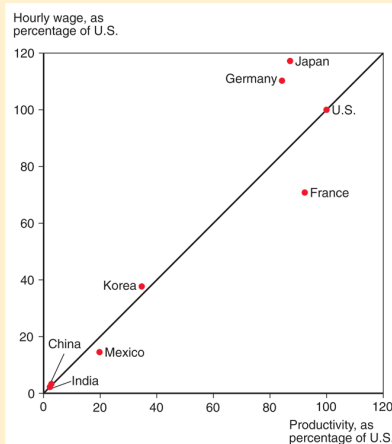
Do Wages Reflect Productivity?

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

Productivity and Wages

A country's wage rate is roughly proportional to the country's productivity.

Source: International Labor Organization, World Bank, Bureau of Labor Statistics, and Orley Ashenfelter and Stepan Jurajda, "Cross-country Comparisons of Wage Rates," working paper, Princeton University.



Emergence of China as an export power house

- Relative productivity – a determinant for trade

TABLE 3-3 China versus Germany, 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 Ruoan and Bai Manying, "China's Manufacturing Industry in an International Perspective: A China-Germany Comparison," *Economie internationale*, no. 92-2002/4, pp. 103-130.

- While few economists believe that the Ricardian model is a fully adequate description of the causes and consequences of world trade, its two principal implications—that **productivity differences play an important role in international trade** and that it is **comparative rather than absolute advantage that matters**—do seem to be supported by the evidence.

Key points in the Ricaridan model (Read more at page 47)

1. Comparative advantage rather than absolute advantage that matters and determine trade.
2. Comparative advantage: lower opportunity cost
3. Assumptions of the model
4. To determine what a country does produce, must determine relative prices and compare with opportunity cost
 - Relative price $>$ opportunity cost $\Rightarrow$ produce only that product
 - In autarky, produce both products and thus relative price of wine = opportunity cost of wine or wages = relative prices of wine

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Key points in the Ricaridan model (cont.)

5. Conditions for trade to take place: Construct relative supply curve, relative demand curves and identify conditions for trade to take place: i.e. international relative price must lie between two pre-trade (autarky) prices.
6. The process of relative prices changes in two countries from autarky to presence of trade.
7. Every country can take part in trade. Trade is predicted to benefit both high productivity and low productivity countries.

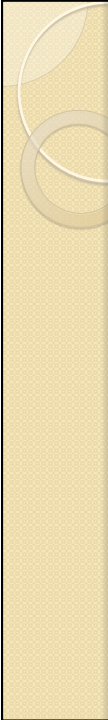
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Key points in the Ricaridan model (cont.)

9. In Multi-good model:
 - Pattern of trade: depends on the relative wages.
 - Specialize in and export commodity when relative productivity > relative wage
10. Limitations of the model
11. Empirical evidence supports:
 - Trade based on comparative advantage
 - Source for comparative is difference in productivity

Key points in the Ricaridan model (cont.)

- Exercise:
 - PPF: Develop function, sketch in a diagram, identify slope
 - Identify comparative advantage bases on PPF and opportunity costs => Identify production points (extreme specialization) and trade pattern in two-goods model
 - Relative supply curve: how to construct, identify relative supply of the world
 - Identify conditions for trade to take place
 - Identify trade pattern in multiple-goods model



END OF CHAPTER 3