

**Chapter 2**  
**Labor Productivity and Comparative Advantage:**  
**The Ricardian Model**



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 To Accompany  
**International Economics: Theory and Policy, Sixth Edition**  
 by **Paul R. Krugman and Maurice Obstfeld**

**Chapter Organization**

- Introduction
- The Concept of Comparative Advantage
- A One-Factor Economy
- Trade in a One-Factor World
- Misconceptions About Comparative Advantage
- Comparative Advantage with Many Goods
- Adding Transport Costs and Nontraded Goods
- Empirical Evidence on the Ricardian Model
- Summary

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**Introduction**

- Countries engage in international trade for two basic reasons:
  - They are different from each other in terms of climate, land, capital, labor, and technology.
  - They try to achieve scale economies in production.
- The **Ricardian model** is based on technological differences across countries.
  - These technological differences are reflected in differences in the productivity of labor.

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**The Concept of Comparative Advantage**

- On Valentine's Day the U.S. demand for roses is about 10 million roses.
- Growing roses in the U.S. in the winter is difficult.
  - Heated greenhouses should be used.
  - The costs for energy, capital, and labor are substantial.
- Resources for the production of roses could be used to produce other goods, say computers.

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**The Concept of Comparative Advantage**

- **Opportunity Cost**
  - The opportunity cost of roses in terms of computers is the number of computers that could be produced with the same resources as a given number of roses.
- **Comparative Advantage**
  - A country has a comparative advantage in producing a good if the opportunity cost of producing that good in terms of other goods is lower in that country than it is in other countries.

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**The Concept of Comparative Advantage**

- Suppose that in the U.S. 10 million roses can be produced with the same resources as 100,000 computers.
- Suppose also that in Mexico 10 million roses can be produced with the same resources as 30,000 computers.
- This example assumes that Mexican workers are less productive than U.S. workers.

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## The Concept of Comparative Advantage

- If each country specializes in the production of the good with lower opportunity costs, trade can be beneficial for both countries.
  - Roses have lower opportunity costs in Mexico.
  - Computers have lower opportunity costs in the U.S.
- The benefits from trade can be seen by considering the changes in production of roses and computers in both countries.

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## The Concept of Comparative Advantage

Table 2-1: Hypothetical Changes in Production

	Million Roses	Thousand Computers
United States	-10	+100
South America	+10	-30
Total	0	+70

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## The Concept of Comparative Advantage

- The example in Table 2-1 illustrates the principle of comparative advantage:
  - If each country exports the goods in which it has comparative advantage (lower opportunity costs), then all countries can in principle gain from trade.
- What determines comparative advantage?
  - Answering this question would help us understand how country differences determine the pattern of trade (which goods a country exports).

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## A One-Factor Economy

- Assume that we are dealing with an economy (which we call Home). In this economy:
  - Labor is the only factor of production.
  - Only two goods (say wine and cheese) are produced.
  - The supply of labor is fixed in each country.
  - The productivity of labor in each good is fixed.
  - Perfect competition prevails in all markets.

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## A One-Factor Economy

- The constant labor productivity is modeled with the specification of unit labor requirements:
  - The **unit labor requirement** is the number of hours of labor required to produce one unit of output.
    - Denote with  $a_{LW}$  the unit labor requirement for wine (e.g. if  $a_{LW} = 2$ , then one needs 2 hours of labor to produce one gallon of wine).
    - Denote with  $a_{LC}$  the unit labor requirement for cheese (e.g. if  $a_{LC} = 1$ , then one needs 1 hour of labor to produce a pound of cheese).
- The economy's total resources are defined as  $L$ , the total labor supply (e.g. if  $L = 120$ , then this economy is endowed with 120 hours of labor or 120 workers).

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## A One-Factor Economy

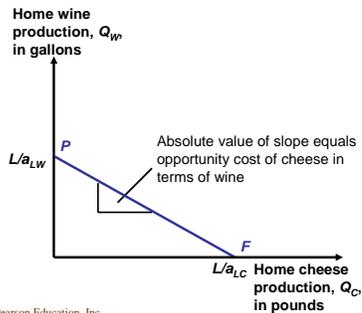
- **Production Possibilities**
  - The **production possibility frontier** (PPF) of an economy shows the maximum amount of a good (say wine) that can be produced for any given amount of another (say cheese), and vice versa.
  - The PPF of our economy is given by the following equation:
 
$$a_{LC}Q_C + a_{LW}Q_W = L \quad (2-1)$$
  - From our previous example, we get:
 
$$Q_C + 2Q_W = 120$$

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## A One-Factor Economy

Figure 2-1: Home's Production Possibility Frontier



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## A One-Factor Economy

### Relative Prices and Supply

- The particular amounts of each good produced are determined by prices.
- The relative price of good  $X$  (cheese) in terms of good  $Y$  (wine) is the amount of good  $Y$  (wine) that can be exchanged for one unit of good  $X$  (cheese).
- Examples of relative prices:
  - If a price of a can of Coke is \$0.5, then the relative price of Coke is the amount of \$ that can be exchanged for one unit of Coke, which is 0.5.
  - The relative price of a \$ in terms of Coke is 2 cans of Coke per dollar.

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## A One-Factor Economy

- Denote with  $P_C$  the dollar price of cheese and with  $P_W$  the dollar price of wine. Denote with  $w_W$  the dollar wage in the wine industry and with  $w_C$  the dollar wage in the cheese industry.
- Then under perfect competition, the non-negative profit condition implies:
  - If  $P_W/a_W < w_W$ , then there is no production of  $Q_W$ .
  - If  $P_W/a_W = w_W$ , then there is production of  $Q_W$ .
  - If  $P_C/a_C < w_C$ , then there is no production of  $Q_C$ .
  - If  $P_C/a_C = w_C$ , then there is production of  $Q_C$ .

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## A One-Factor Economy

- The above relations imply that if the relative price of cheese ( $P_C/P_W$ ) exceeds its opportunity cost ( $a_{LC}/a_{LW}$ ), then the economy will specialize in the production of cheese.
- In the absence of trade, both goods are produced, and therefore  $P_C/P_W = a_{LC}/a_{LW}$ .

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## Trade in a One-Factor World

- Assumptions of the model:
  - There are two countries in the world (Home and Foreign).
  - Each of the two countries produces two goods (say wine and cheese).
  - Labor is the only factor of production.
  - The supply of labor is fixed in each country.
  - The productivity of labor in each good is fixed.
  - Labor is not mobile across the two countries.
  - Perfect competition prevails in all markets.
  - All variables with an asterisk refer to the Foreign country.

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## Trade in a One-Factor World

### Absolute Advantage

- A country has an **absolute advantage** in a production of a good if it has a lower unit labor requirement than the foreign country in this good.
- Assume that  $a_{LC} < a_{LC}^*$  and  $a_{LW} < a_{LW}^*$ 
  - This assumption implies that Home has an absolute advantage in the production of both goods. Another way to see this is to notice that Home is more productive in the production of both goods than Foreign.
  - Even if Home has an absolute advantage in both goods, beneficial trade is possible.
- The pattern of trade will be determined by the concept of comparative advantage.

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## Trade in a One-Factor World

### Comparative Advantage

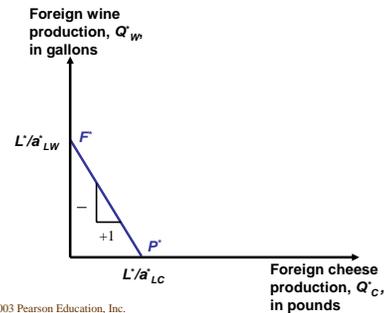
- Assume that  $a_{LC}/a_{LW} < a^*_{LC}/a^*_{LW}$  (2-2)
  - This assumption implies that the opportunity cost of cheese in terms of wine is lower in Home than it is in Foreign.
  - In other words, in the absence of trade, the relative price of cheese at Home is lower than the relative price of cheese at Foreign.
- Home has a comparative advantage in cheese and will export it to Foreign in exchange for wine.

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## Trade in a One-Factor World

Figure 2-2: Foreign's Production Possibility Frontier



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## Trade in a One-Factor World

### Determining the Relative Price After Trade

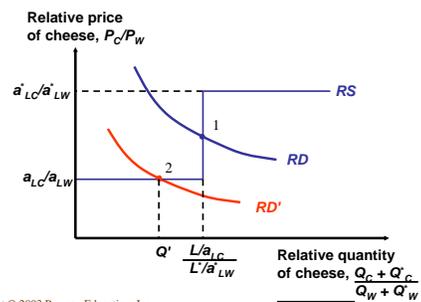
- What determines the relative price (e.g.,  $P_C/P_W$ ) after trade?
  - To answer this question we have to define the relative supply and relative demand for cheese in the world as a whole.
  - The **relative supply** of cheese equals the total quantity of cheese supplied by both countries at each given relative price divided by the total quantity of wine supplied,  $(Q_C + Q^*_C)/(Q_W + Q^*_W)$ .
  - The **relative demand** of cheese in the world is a similar concept.

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## Trade in a One-Factor World

Figure 2-3: World Relative Supply and Demand



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## Trade in a One-Factor World

### The Gains from Trade

- If countries specialize according to their comparative advantage, they all gain from this specialization and trade.
- We will demonstrate these gains from trade in two ways.
- First, we can think of trade as a new way of producing goods and services (that is, a new technology).

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## Trade in a One-Factor World

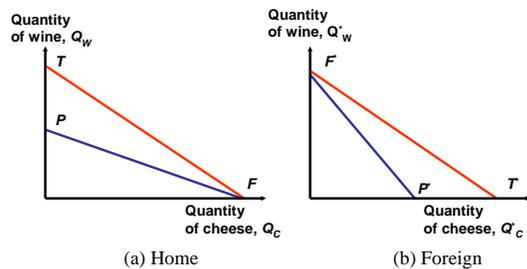
- Another way to see the gains from trade is to consider how trade affects the consumption in each of the two countries.
- The consumption possibility frontier states the maximum amount of consumption of a good a country can obtain for any given amount of the other commodity.
- In the absence of trade, the consumption possibility curve is the same as the production possibility curve.
- Trade enlarges the consumption possibility for each of the two countries.

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## Trade in a One-Factor World

Figure 2-4: Trade Expands Consumption Possibilities



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## Trade in a One-Factor World

### A Numerical Example

- The following table describes the technology of the two countries:

Table 2-2: Unit Labor Requirements

	Cheese	Wine
Home	$a_{LC} = 1$ hour per pound	$a_{LW} = 2$ hours per gallon
Foreign	$a_{LC}^* = 6$ hours per pound	$a_{LW}^* = 3$ hours per gallon

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## Trade in a One-Factor World

- The previous numerical example implies that:

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

- In world equilibrium, the relative price of cheese must lie between these values. Assume that  $P_c/P_w = 1$  gallon of wine per pound of cheese.
- Both countries will specialize and gain from this specialization.
  - Consider Home, which can transform wine to cheese by either producing it internally or by producing cheese and then trading the cheese for wine.

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## Trade in a One-Factor World

- Home can use one hour of labor to produce  $1/a_{LW} = 1/2$  gallon of wine if it does not trade.
- Alternatively, it can use one hour of labor to produce  $1/a_{LC} = 1$  pound of cheese, sell this amount to Foreign, and obtain 1 gallon of wine.

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## Trade in a One-Factor World

- In the absence of trade, Foreign can use one unit of labor to produce  $1/a_{LC}^* = 1/6$  pound of cheese using the domestic technology.
- Can it do better by specializing in wine and trading wine with Home for cheese?
- In the presence of trade, Foreign can use one unit of labor to produce  $1/a_{LW}^* = 1/3$  gallon of wine.
- Since the world price of wine is  $P_w/P_c = 1$  pound of cheese per gallon, Foreign can obtain 1/3 lb of cheese which is more than 1/6 lb.

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## Trade in a One-Factor World

### Relative Wages

- Because there are technological differences between the two countries, trade in goods does not make the wages equal across the two countries.
- A country with absolute advantage in both goods will enjoy a higher wage after trade.

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## Trade in a One-Factor World

- This can be illustrated with the help of a numerical example:
  - Assume that  $P_C = \$12$  and that  $P_W = \$12$ . Therefore, we have  $P_C / P_W = 1$  as in our previous example.
  - Since Home specializes in cheese after trade, its wage will be  $(1/a_{LC})P_C = (1/1)\$12 = \$12$ .
  - Since Foreign specializes in wine after trade, its wage will be  $(1/a_{LW}^*)P_W = (1/3)\$12 = \$4$ .
  - Therefore the relative wage of Home will be  $\$12/\$4 = 3$ .
  - Thus, the country with the higher absolute advantage will enjoy a higher wage after trade.

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## Misconceptions About Comparative Advantage

- Productivity and Competitiveness**
  - Myth 1: Free trade is beneficial only if a country is strong enough to withstand foreign competition.
    - This argument fails to recognize that trade is based on comparative not absolute advantage.
- The Pauper Labor Argument**
  - Myth 2: Foreign competition is unfair and hurts other countries when it is based on low wages.
    - Again in our example Foreign has lower wages but still benefits from trade.

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## Misconceptions About Comparative Advantage

- Exploitation**
  - Myth 3: Trade makes the workers worse off in countries with lower wages.
    - In the absence of trade these workers would be worse off.
    - Denying the opportunity to export is to condemn poor people to continue to be poor.

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## Misconceptions About Comparative Advantage

Table 2-3: Changes in Wages and Unit Labor Costs

	Compensation per Hour, 1975 (US = 100)	Compensation per Hour, 2000 (US = 100)	Annual Rate of Increase in Unit Labor Costs, 1979–2000
United States	100	100	1.1
South Korea	5	41	.07
Taiwan	6	30	3.6
Hong Kong	12	28	NA
Singapore	13	37	NA

Source: Bureau of Labor Statistics (foreign labor statistics home page, [www.bls.gov/fls/home.htm](http://www.bls.gov/fls/home.htm))

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## Comparative Advantage with Many Goods

- Setting Up the Model**
  - Both countries consume and are able to produce a large number,  $N$ , of different goods.
- Relative Wages and Specialization**
  - The pattern of trade will depend on the ratio of Home to Foreign wages.
  - Goods will always be produced where it is cheapest to make them.
    - For example, it will be cheaper to produce good  $i$  in Home if  $w a_{Li} < w^* a_{Li}^*$ , or by rearranging if  $a_{Li}^*/a_{Li} > w/w^*$ .

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## Comparative Advantage with Many Goods

Table 2-4: 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

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## Comparative Advantage with Many Goods

- Which country produces which goods?
  - A country has a cost advantage in any good for which its relative productivity is higher than its relative wage.
    - If, for example,  $w/w^* = 3$ , Home will produce apples, bananas, and caviar, while Foreign will produce only dates and enchiladas.
    - Both countries will gain from this specialization.

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## Comparative Advantage with Many Goods

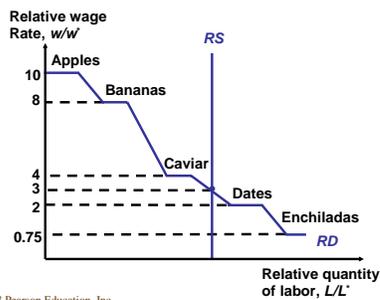
- Determining the Relative Wage in the Multigood Model
  - To determine relative wages in a multigood economy we must look behind the relative demand for goods (i.e., the **relative derived demand**).
  - The relative demand for Home labor depends negatively on the ratio of Home to Foreign wages.

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## Comparative Advantage with Many Goods

Figure 2-5: Determination of Relative Wages



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## Adding Transport Costs and Nontraded Goods

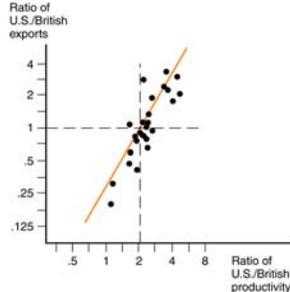
- There are three main reasons why specialization in the real international economy is not extreme:
  - The existence of more than one factor of production.
  - Countries sometimes protect industries from foreign competition.
  - It is costly to transport goods and services.
- The result of introducing transport costs makes some goods **nontraded**.
- In some cases transportation is virtually impossible.
  - Example: Services such as haircuts and auto repair cannot be traded internationally.

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## Empirical Evidence on the Ricardian Model

Figure 2-6: Productivity and Exports



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## Summary

- We examined the Ricardian model, the simplest model that shows how differences between countries give rise to trade and gains from trade.
- In this model, labor is the only factor of production and countries differ only in the productivity of labor in different industries.
- In the Ricardian model, a country will export that commodity in which it has comparative (as opposed to absolute) labor productivity advantage.

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## Summary



- The fact that trade benefits a country can be shown in either of two ways:
  - We can think of trade as an indirect method of production.
  - We can show that trade enlarges a country's consumption possibilities.
- The distribution of the gains from trade depends on the relative prices of the goods countries produce.

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## Summary



- Extending the one-factor, two-good model to a world of many commodities makes it possible to illustrate that transportation costs can give rise to the existence of nontraded goods.
- The basic prediction of the Ricardian model-that countries will tend to export goods in which they have relatively high productivity- has been confirmed by a number of studies.

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