Trade and Technology: The Ricardian Model
ECON 6280 - Introduction of International Economics

Week 1 / Lecture 2 / Note 2

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Introduction

In this chapter, we will:

- Learn the reasons countries trade

- Distinguish between **absolute** and **comparative advantage**

- Understand the **Ricardian model**

- Understand the no-trade equilibrium using each country's PPF and **indifference curve**

- Solve for wages across countries

- Solve for **international prices by** deriving the home **export supply** and Foreign **import demand curve** and how to arrive at **international trade equilibrium**

Reasons countries trade goods with each other

- Differences in the **technology** used in each country (i.e., differences in each country's ability to manufacture products)

- Differences in the total amount of **resources** (including labor, capital, and land) found in each country [Will see it in two chapters Hecksher-Ohlin Model!]

- Differences in the costs of **offshoring** (i.e., producing the various parts of a good in different countries and then assembling it in a final location)

- The **proximity** of countries to each other (i.e., how close they are to one another) [We have seen earlier today!]

Introduction

In this chapter, we focus on technology differences across countries as an explanation for trade, called the Ricardian model.

- The Ricardian model explains how the level of a country's **technology** affects its **trade pattern**.

- It also explains the concept of comparative advantage and why it works as an explanation for trade patterns.

1 Reasons for Trade

Proximity

- The closer countries are, the lower the costs of transportation. For example, the largest trading partner of most European countries is another European country.

Resources

- Geography includes **natural resources**, as well as **labor resources** and **capital**. A country's resources are often collectively called its **factors of production**, the land, labor, and capital used to produce goods and services.

  [Take a look of the textbook's example! i.e. U.S. snowboard imported.]

1 Reasons for Trade

Absolute Advantage

- When a country has the best technology for producing a good, it has an **absolute advantage** in the production of that good.

- Absolute advantage is not a good explanation for trade patterns.

Comparative Advantage

- Instead, **comparative advantage** is the primary explanation for trade among countries.

- A country has comparative advantage in producing those goods that it produces best *compared with* how well it produces other goods.

2 Ricardian Model

The Home Country

To develop a Ricardian model of trade, we will use an example with two goods:

- Wheat and other grains are major exports of the United States and Europe.

- Many types of cloth are imported into these countries.

For simplicity, we ignore the role of land and capital and suppose that both goods are produced with labor alone.

The Home Country

We assume that labor is the only resource used to produce goods. The **marginal product of labor (MPL)** is the extra output obtained by using one more unit of labor.

- In Home, one worker produces 4 bushels of wheat, so $MPL_W = 4$.

- Alternatively, one worker can produce 2 yards of cloth, so $MPL_C = 2$.

2 Ricardian Model

The Home Country

Home Production Possibilities Frontier

- We can graph Home's **production possibilities frontier** (PPF) using the marginal products for wheat and cloth.

- The slope of the PPF is also the **opportunity cost** of wheat, the amount of cloth that must be given up to obtain one more unit of wheat.

- If Home had 25 workers and all were employed in wheat, Home could produce 100 bushels. If all were employed in cloth, they could produce 50 yards.

The Home Country

Home Production Possibilities Frontier

FIGURE 2-1
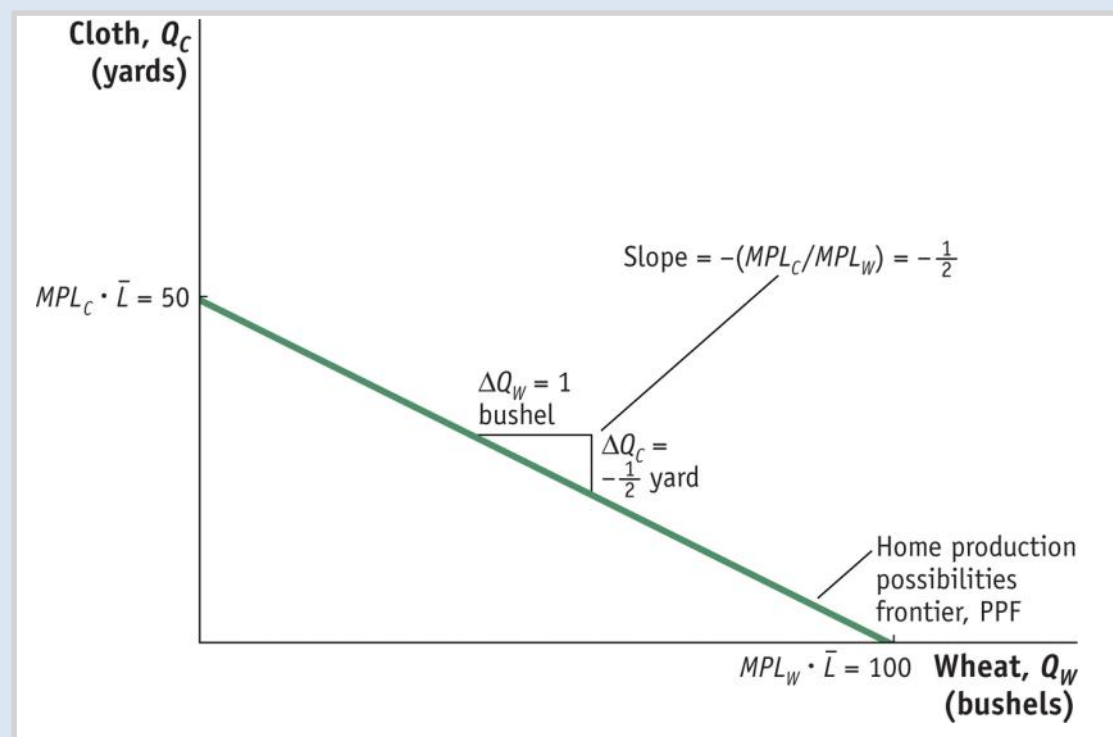
The Home PPF is a straight line between 50 yards of cloth and 100 bushels of wheat.

The slope of the PPF equals the negative of the opportunity cost of wheat. Equivalently, the magnitude of the slope can be expressed as the ratio of the marginal products of labor for the two goods.

$$Slope\ of\ PPF = -\frac{50}{100} = -\frac{MPL_C \cdot \bar{L}}{MPL_W \cdot \bar{\bar{L}}} = -\frac{MPL_C}{MPL_W} = -\frac{1}{2}$$

2 Ricardian Model

The Home Country
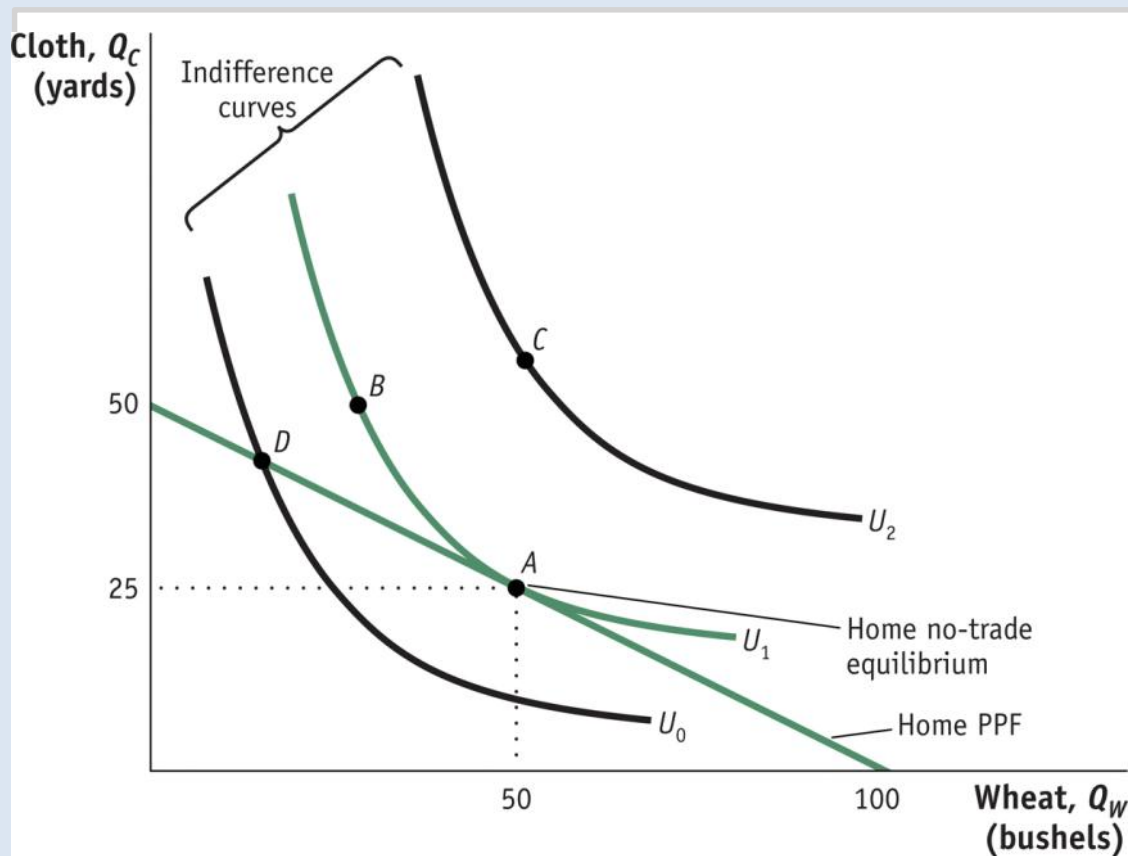
Home Indifference Curve

We will represent demand in the Home economy using indifference curves that have the following properties:

- All points on an indifference curve have the same level of **utility**.

- Points on higher indifference curves have higher utility.

- Each indifference curve shows the combinations of two goods, such as wheat and cloth, that a person or economy can consume and be equally satisfied.

Home Indifference Curve

FIGURE 2-2	Home Equilibrium with No Trade

Points A and B lie on the same indifference curve and give the Home consumers the level of utility U_1.

The highest level of Home utility on the PPF is obtained at point A, which is the no-trade equilibrium.

Point D is also on the PPF but would give lower utility.

Point C represents a higher utility level but is off of the PPF, so it is not attainable in the absence of international trade.

The Home Country

Opportunity Cost and Prices

- The slope of the PPF reflects the opportunity cost of producing one more bushel of wheat.

- Under perfect competition the opportunity cost of wheat should also equal the **relative price** of wheat.

- *Price reflects the opportunity cost of a good.*

The Home Country

Wages

- In competitive markets firms hire workers up to the point at which the hourly wage equals the value of one more hour of production.

- The value of one more hour of labor equals the amount of goods produced in that hour (MPL) times the price of the good.

- Labor will be hired up to the point where wage equals $P \cdot MPL$ for each industry.

2 Ricardian Model

The Home Country

Wages

- Use the equality of the wage across industries to obtain the following equation:

$$P_W \cdot MPL_W = P_C \cdot MPL_C$$

- Rearranging terms, we see that

$$P_W/P_C = MPL_C/MPL_W$$

- The right-hand side of the equation is the slope of the production possibilities frontier (the opportunity cost of one more bushel of wheat).

- The left-hand side of the equation is the relative price of wheat.

The Foreign Country

- Assume a Foreign worker can produce one bushel of wheat or one yard of cloth.

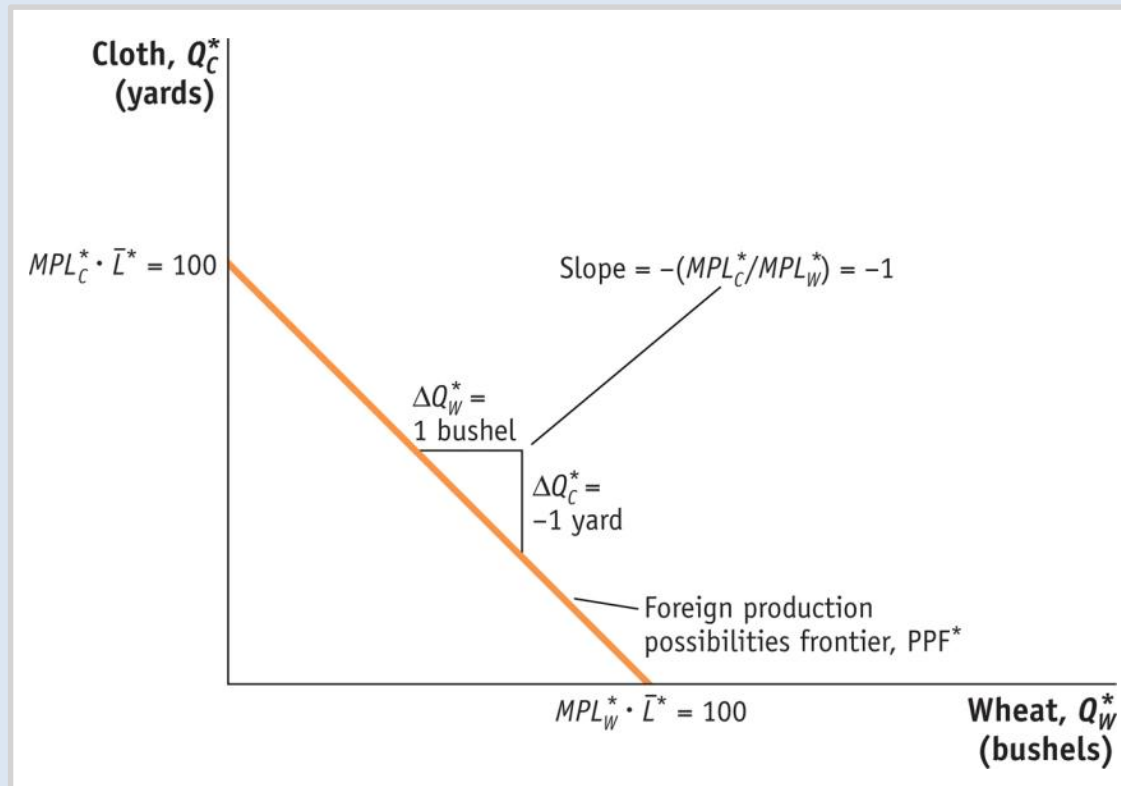$$MPL^*_W = 1, \ MPL^*_C = 1$$

- Assume there are 100 workers available in Foreign.

- If all workers were employed in wheat, they could produce 100 bushels.

- If all workers were employed in cloth, they could produce 100 yards.

- It is worth noting that Home country has absolute advantage in both goods, but will export only one as explained later.

2 Ricardian Model

The Foreign Country

Foreign Production Possibilities Frontier

FIGURE 2-3

Cloth, Q_C^* (yards)

$MPL_C^* \cdot \bar{L}^* = 100$

Slope $= -(MPL_C^*/MPL_W^*) = -1$

$\Delta Q_W^* = 1$ bushel

$\Delta Q_C^* = -1$ yard

Foreign production possibilities frontier, PPF*

$MPL_W^* \cdot \bar{L}^* = 100$

Wheat, Q_W^* (bushels)

The Foreign PPF is a straight line between 100 yards of cloth and 100 bushels of wheat.

The slope of the PPF equals the negative of the opportunity cost of wheat.

The opportunity cost is the amount of cloth that must be given up (1 yard) to obtain 1 more bushel of wheat.

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Comparative Advantage

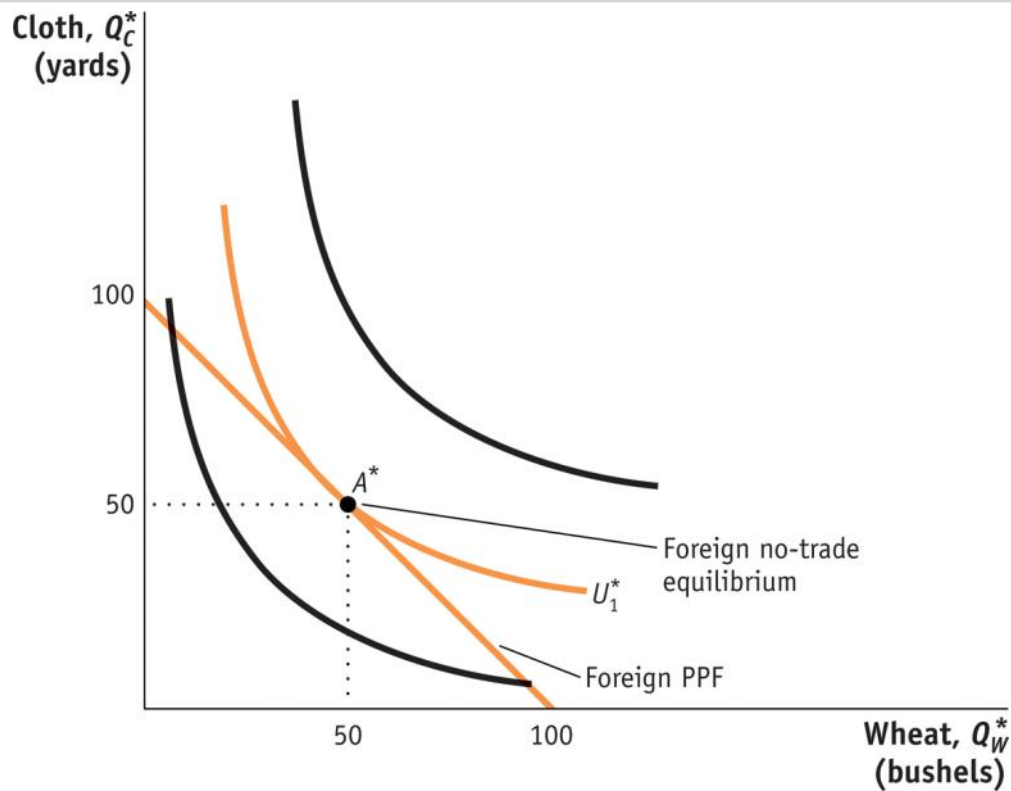|	Cloth (1 Yard)	Wheat (1 Bushel)
Home	2 Bushels of Wheat	½ Yard of Cloth
Foreign	1 Bushel of Wheat	1 Yard of Cloth

- A country has a comparative advantage in a good when it has a lower opportunity cost of producing than another country.

- By looking at the chart we can see that Foreign has a comparative advantage in producing cloth. Home has a comparative advantage in producing wheat.

The Foreign Country

Comparative Advantage

FIGURE 2-4	Foreign Equilibrium with No Trade

Cloth, Q_C^* (yards)

100

50

A^*

Foreign no-trade equilibrium

U_1^*

Foreign PPF

50 100

Wheat, Q_W^* (bushels)

The highest level of Foreign utility on the PPF is obtained at point A^*, which is the no-trade equilibrium.

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Comparative Advantage in Apparel, Textiles, and Wheat

TABLE 2-2	Apparel, Textiles, and Wheat in the United States and China

This table presents sales per employee for the apparel and textile industries in the United States and China, as well as bushels per hour in producing wheat. The United States has an absolute advantage in all of these products, but it has a comparative advantage in producing wheat.

	United States	China	Absolute Advantage
	Sales/Employee	Sales/Employee	U.S./China Ratio
Apparel	$70,000	$27,000	2.6
Textiles	$232,000	$20,000	12
	Bushels/Worker	Bushels/Worker	U.S./China Ratio
Wheat	10,000	300	33
Comparative Advantage			
	Bushels/$	Bushels/$	
Wheat/apparel ratio	0.14	0.01	
Wheat/textile ratio	0.04	0.01	

International Trade Equilibrium

What happens when goods are traded between Home and Foreign? We will see:

- That a country's no-trade relative price determines which product it will export and which it will import

- The no-trade relative price equals its opportunity cost of production

- The pattern of exports and imports will be determined by the opportunity costs of production in each country—*their comparative advantage*

International Trade Equilibrium

Examining each country's no-trade relative price, we can determine which product it will export and which it will import.

- The relative price of cloth in Foreign is $P_C / P_W = 1$.

- The relative price of cloth in Home is $P_C / P_W = 2$.

- Therefore, Foreign would want to export cloth to Home they can make it for $1 and export it for more than $1.

- Home will export wheat and Foreign will export cloth.

Both countries export the good for which they have the comparative advantage.

International Trade Equilibrium

The two countries are in an international trade equilibrium when the relative price of wheat is the same in the two countries.

To fully understand the international trade equilibrium, we are interested in two issues:

- Determining the relative price of wheat (or cloth) in the trade equilibrium

- Seeing how the shift from the no-trade equilibrium to the trade equilibrium affects production and consumption in both Home and Foreign.

International Trade Equilibrium

- The relative price of wheat in the trade equilibrium will be between the no-trade price in the two countries.

- For now assume the free-trade price of P_W/P_C is $\frac{2}{3}$ (between the price of $\frac{1}{2}$ in Home and 1 in Foreign).

- We can now take this price and see how trade changes production and consumption in each country.

- The **world price line** shows the range of *consumption possibilities* that a country can achieve by specializing in one good and engaging in international trade.

International Trade Equilibrium

Change in Production and Consumption

FIGURE 2-5 (1 of 3)	Home Equilibrium with Trade
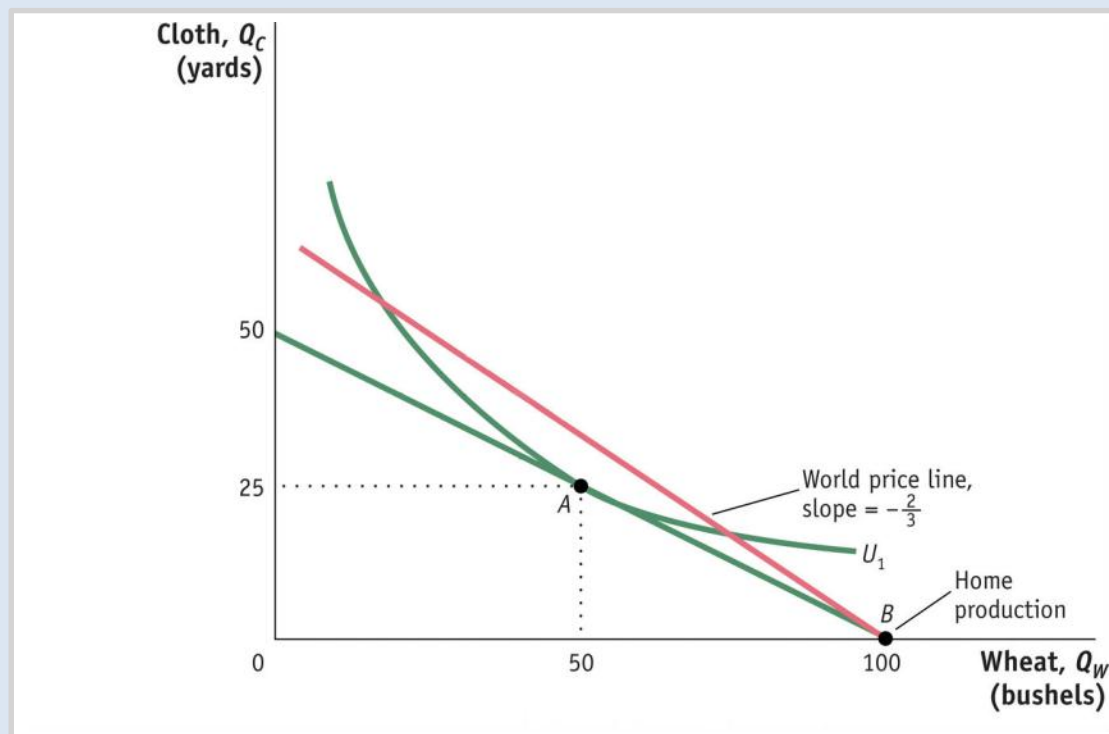
With a world relative price of wheat of $^2/_3$, Home production will occur at point *B*.

Through international trade, Home is able to export each bushel of wheat it produces in exchange for $\frac{2}{3}$ yard of cloth.

International Trade Equilibrium

Change in Production and Consumption

| FIGURE 2-5 (2 of 3) | Home Equilibrium with Trade (continued) |
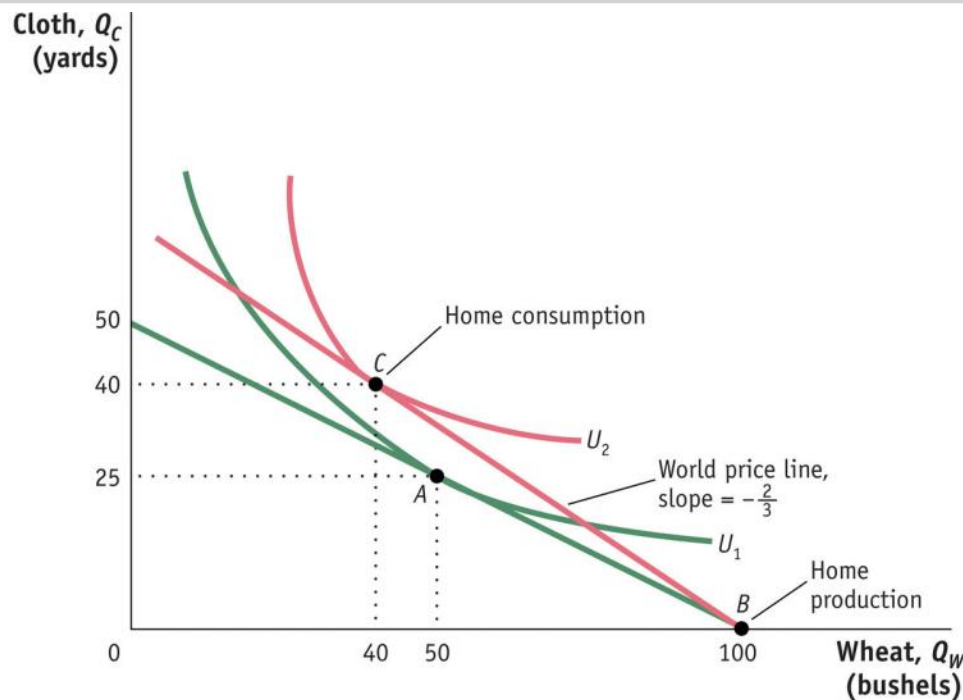
As wheat is exported, Home moves up the world price line *BC.* Home consumption occurs at point *C,* at the tangent intersection with indifference curve U_2, since this is the highest possible utility curve on the world price line.

International Trade Equilibrium

Change in Production and Consumption

| FIGURE 2-5 (3 of 3) | Home Equilibrium with Trade (continued) |
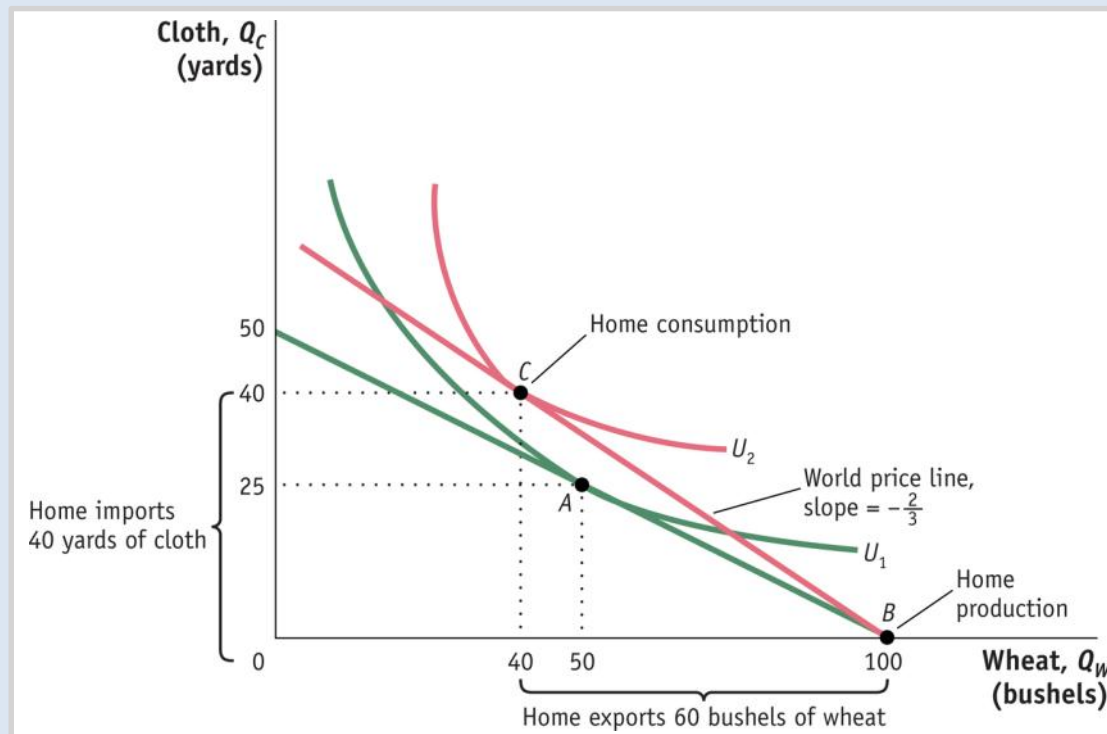
Given these levels of production and consumption, we can see that total exports are 60 bushels of wheat in exchange for imports of 40 yards of cloth and also that Home consumes 10 fewer bushels of wheat and 15 more yards of cloth relative to its pre-trade levels.

International Trade Equilibrium

FIGURE 2-5 (revisited) — Home Equilibrium with Trade
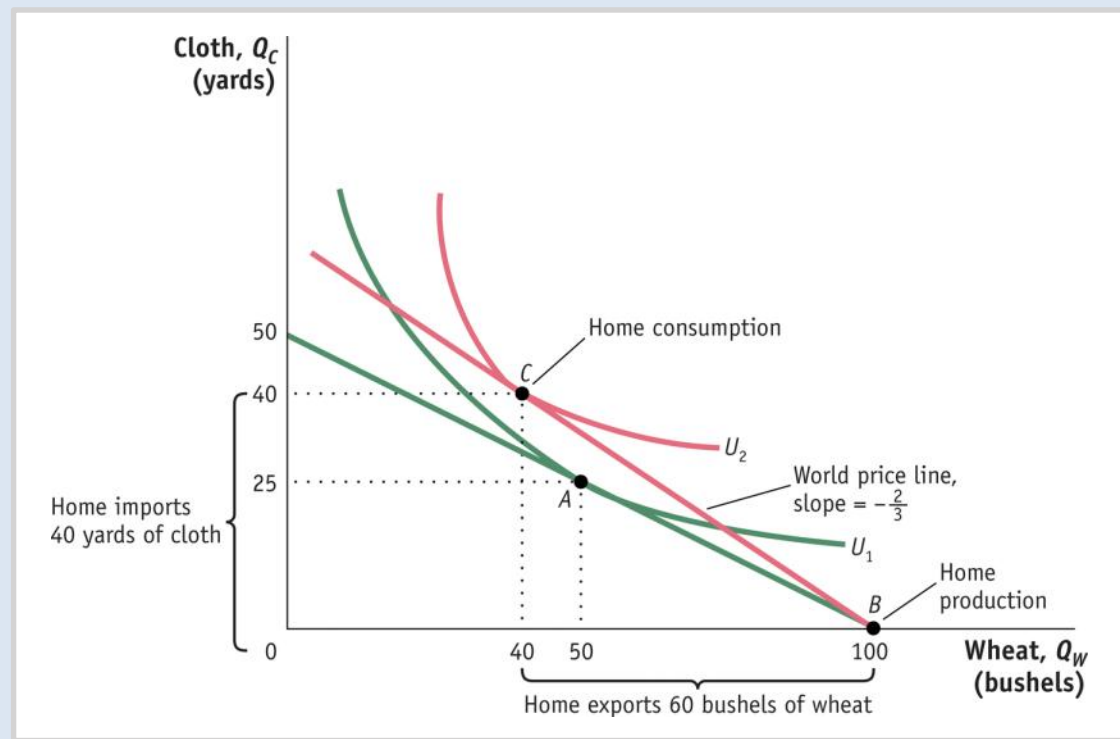
International Trade

Home obtains a higher utility with international trade than in the absence of trade (U_2 is higher than U_1).
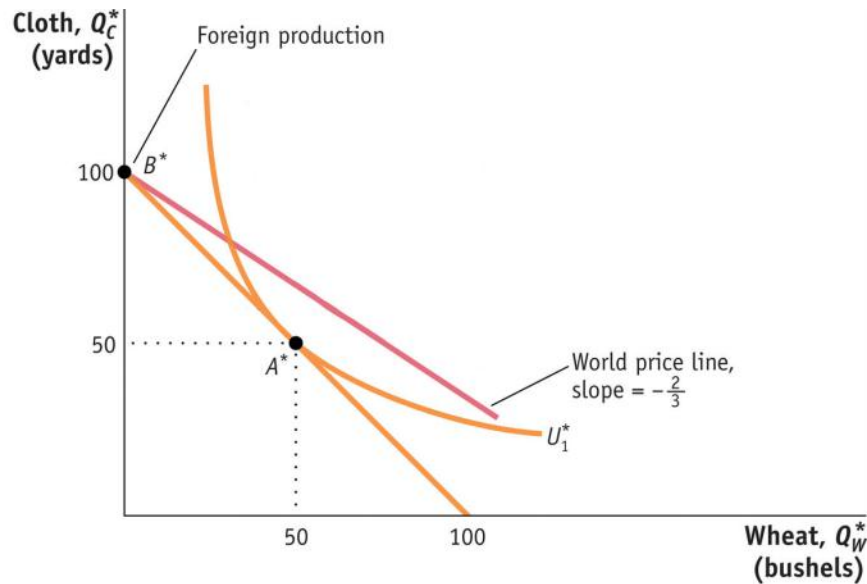
The finding that Home's utility increases with trade is our first demonstration of the **gains from trade**.

International Trade Equilibrium

Pattern of Trade and Gains from Trade

FIGURE 2-6 (1 of 2)	Foreign Equilibrium with Trade

With a world relative price of wheat of $^2/_3$, Foreign production will occur at point B^*.

Through international trade, Foreign is able to export $^2/_3$ yard of cloth in exchange for 1 bushel of wheat, moving down the world price line.
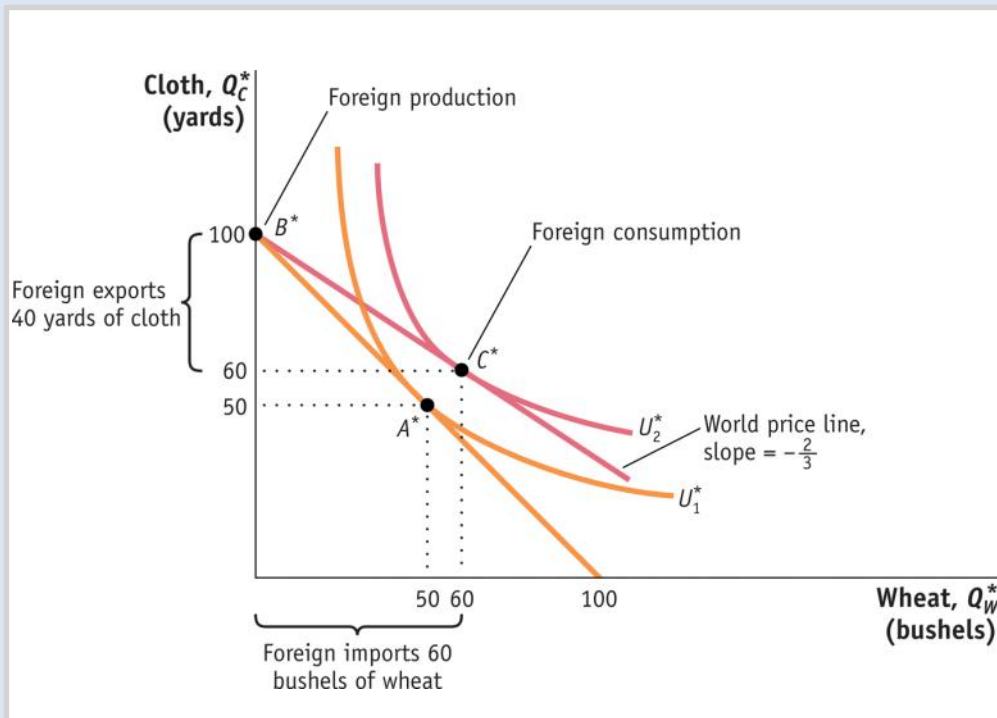
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International Trade Equilibrium

Pattern of Trade and Gains from Trade

FIGURE 2-6 (2 of 2)   Foreign Equilibrium with Trade (continued)

Foreign consumption occurs at point C^*, and total exports are 40 yards of cloth in exchange for imports of 60 bushels of wheat. Relative to its pre-trade wheat and cloth consumption (point A^*), Foreign consumes 10 more bushels of wheat and 10 more yards of cloth.

Pattern of Trade and Gains from Trade

Each country is exporting the good for which it has the comparative advantage.

- This confirms that the pattern of trade is determined by comparative advantage.

- This is the first lesson of the Ricardian model.

There are gains from trade for both countries.

- This is the second lesson of the Ricardian model.

Solving for Wages Across Countries

$$\text{Home Wage} = \begin{cases} MPL_w = 4 \text{ bushels of wheat} \\ \qquad\qquad or \\ \left(P_w/P_c\right). MPL_w = \dfrac{8}{3} \text{ yard of cloth} \end{cases}$$

$$\text{Foreign Wage} = \begin{cases} (P_C^*/P_W^*) \cdot MPL_C^* = \dfrac{3}{2} \text{ bushels of wheat} \\ \qquad\qquad or \\ MPL_C^* = 1 \text{ yard of cloth} \end{cases}$$

Absolute Advantage

As our example shows, wages are determined by absolute advantage. In contrast, the pattern of trade is determined by comparative advantage.

Solving for Wages Across Countries

- In competitive labor markets, firms will pay workers the value of their marginal product.

- Home produces and exports wheat; therefore, they will be paid in terms of that good—the real wage is $MPL_W = 4$ bushels of wheat.

- The workers sell the wheat on the world market at a relative price of $P_W/P_C = 2/3$.

- We can use this to calculate the real wage in terms of cloth: $(P_W/P_C)MPL_W = (2/3)4 = 8/3$ yards.

Solving for Wages Across Countries

- We can do this for Foreign as well and summarize:

  Home real wage is:
    - 4 bushels of wheat or 8/3 yards of cloth

  Foreign real wage is:
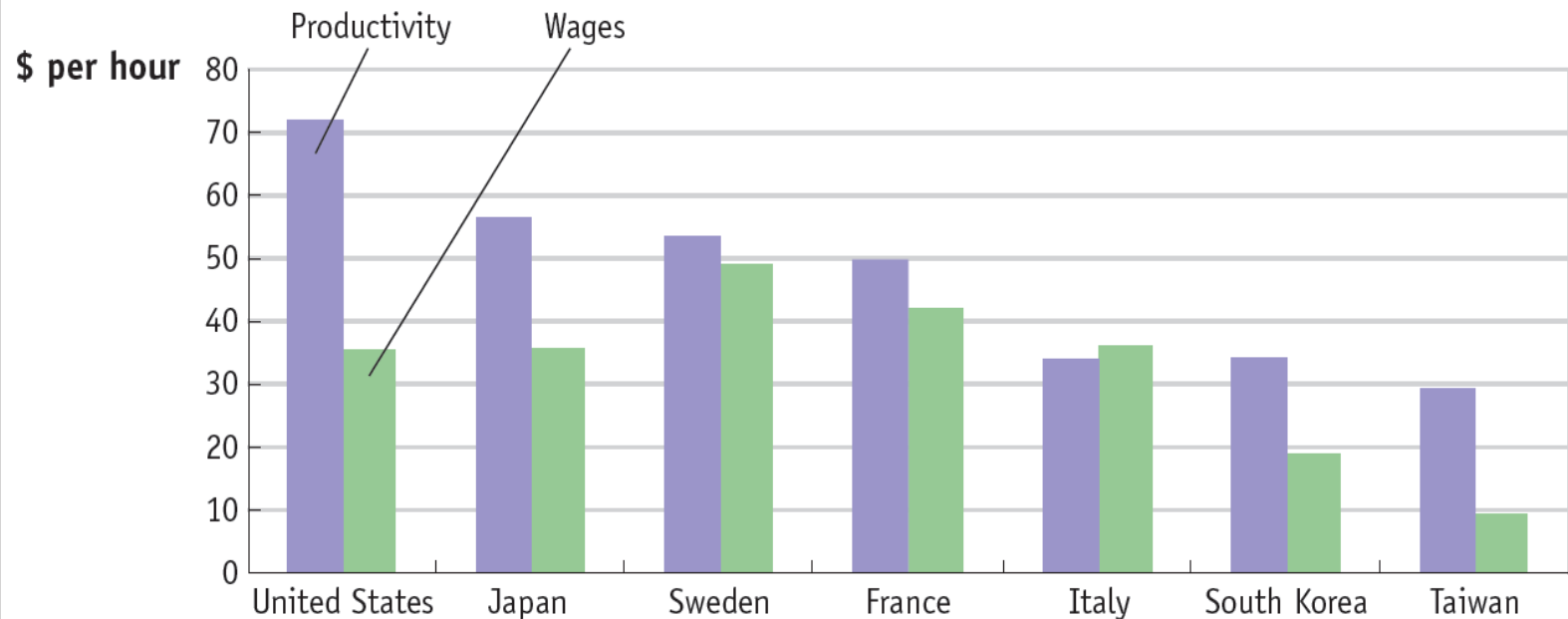   - 3/2 bushels of wheat or 1 yard of cloth

- Foreign workers earn less than Home workers as measured by their ability to purchase either good. (The foreign real wages are still higher compare to autarky.)

- This reflects Home's absolute advantage in the production of both goods.

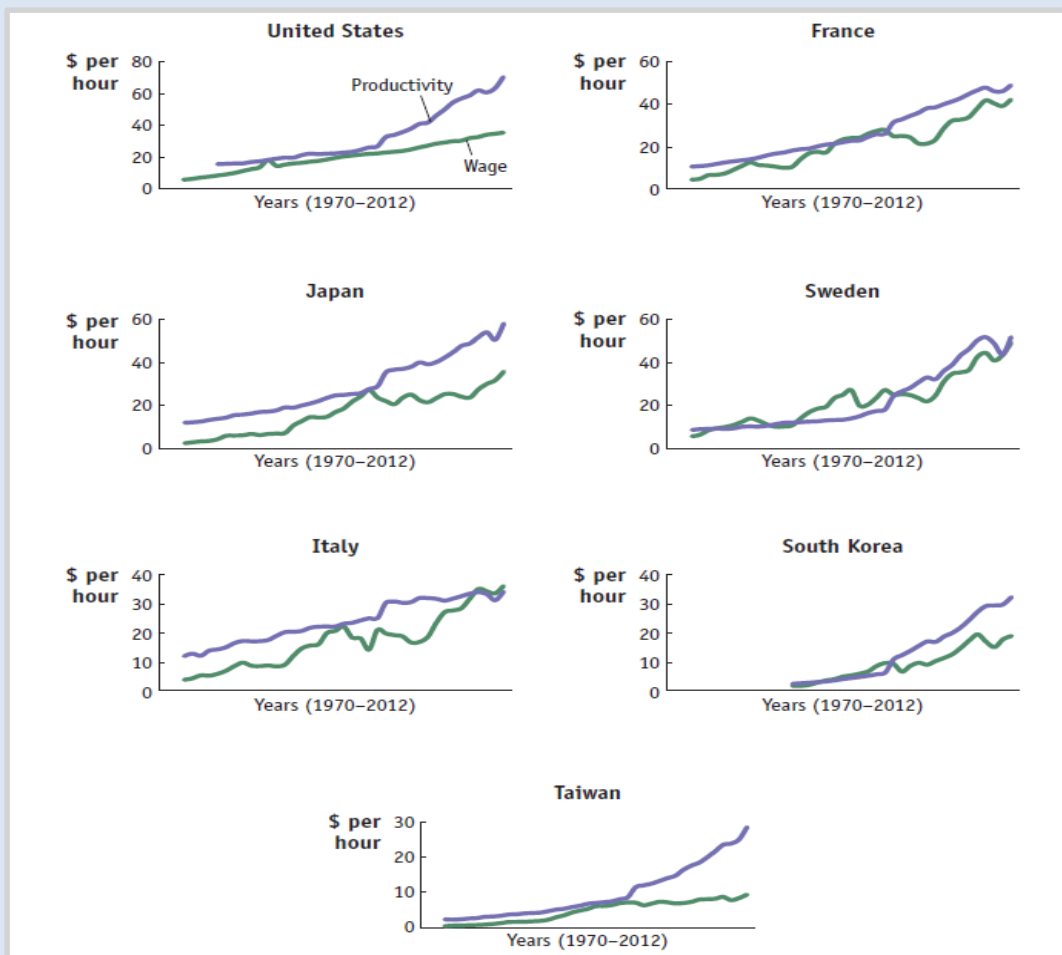## Labor Productivity and Wages

FIGURE 2-7

Labor Productivity and Wages, 2011 Labor productivity is measured by value-added per hour of work and can be compared with the wages paid in manufacturing in various countries.

Countries with higher labor productivity pay higher wages, just as the Ricardian model predicts. But Europe?
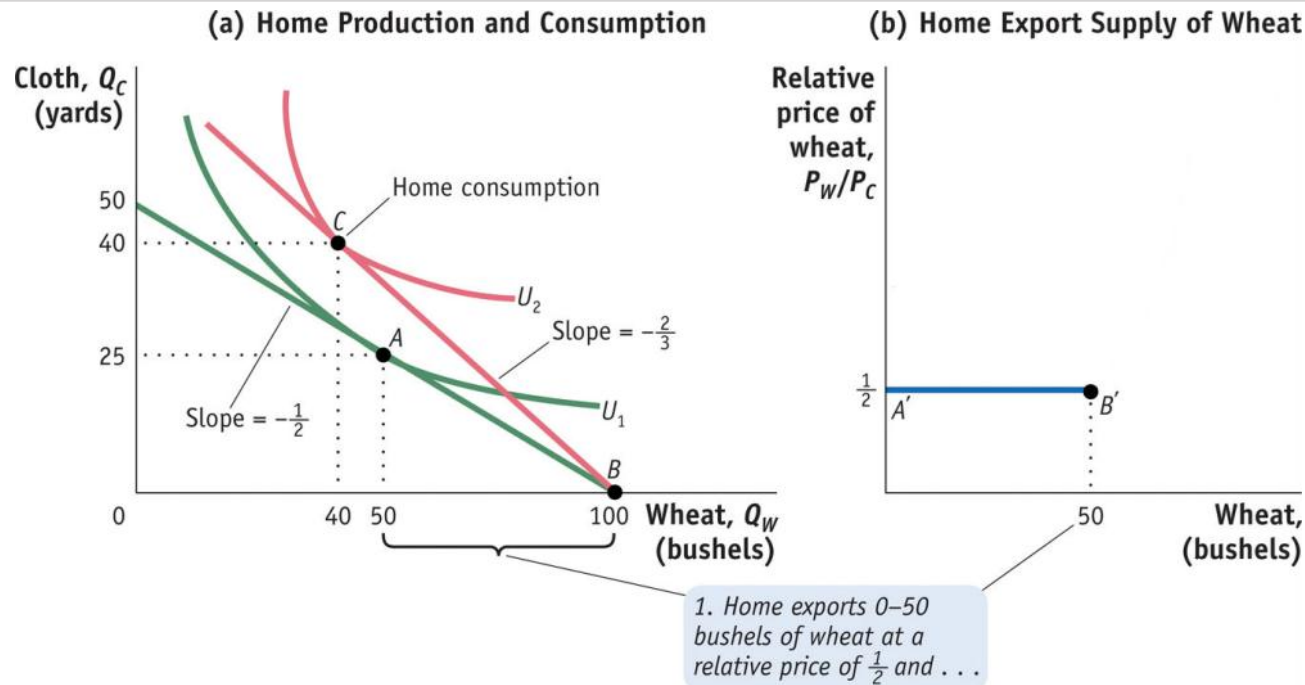
Labor Productivity and Wages

FIGURE 2-8

The trends in labor productivity and wages can also be graphed over time.

The general upward movement in labor productivity is matched by upward movements in wages, as predicted by the Ricardian model.

Home Export Supply Curve

FIGURE 2-9 (1 of 2)

(a) Home Production and Consumption

(b) Home Export Supply of Wheat

1. Home exports 0–50 bushels of wheat at a relative price of $\frac{1}{2}$ and . . .
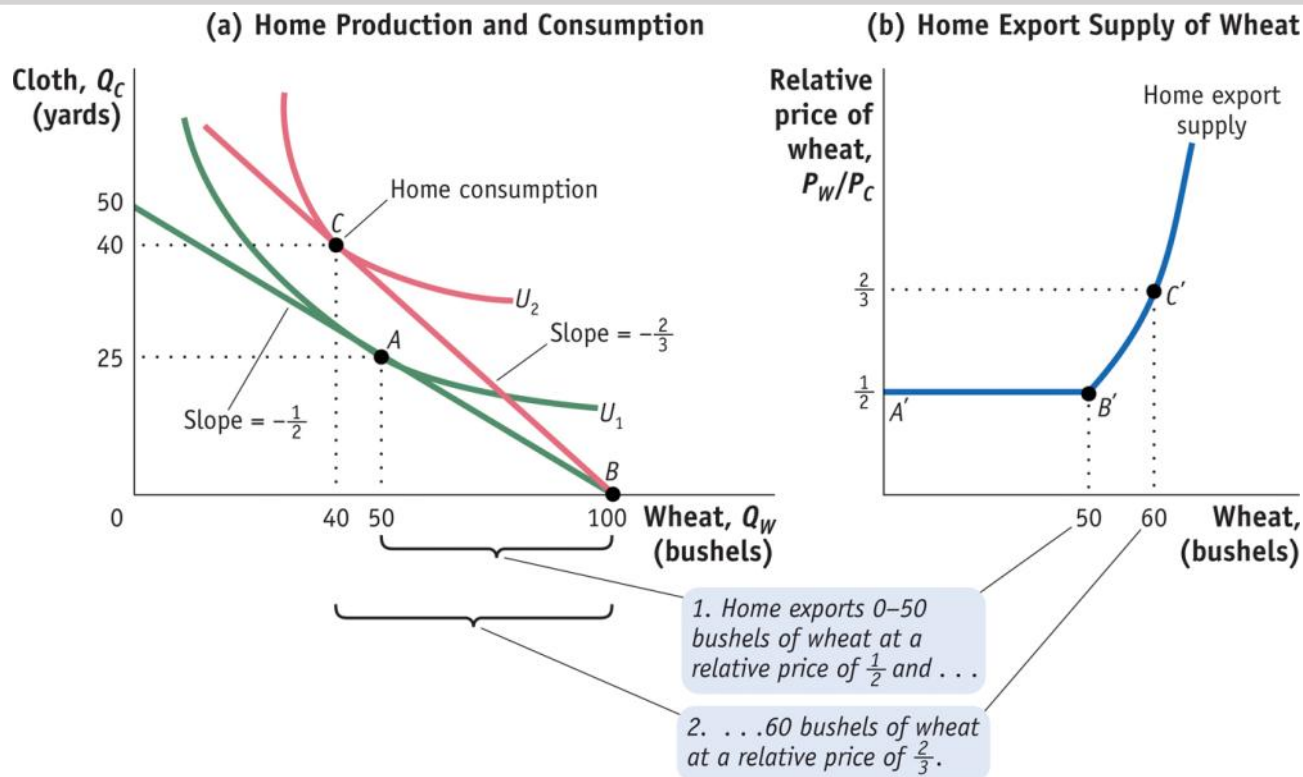
Home Export Supply Panel (a) repeats Figure 2-5 showing the trade equilibrium for Home with production at point B and consumption at point C. Panel (b) shows the Home export supply of wheat.

Home Export Supply Curve

FIGURE 2-9 (2 of 2)

(a) Home Production and Consumption

(b) Home Export Supply of Wheat

1. Home exports 0–50 bushels of wheat at a relative price of $\frac{1}{2}$ and . . .

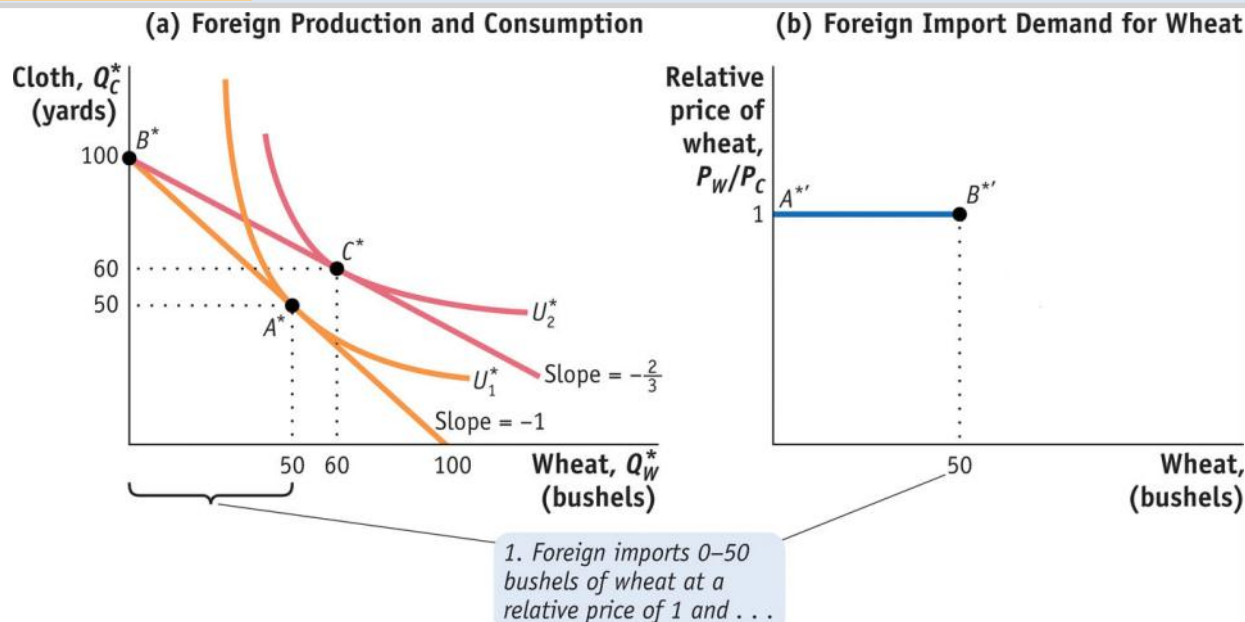2. . . .60 bushels of wheat at a relative price of $\frac{2}{3}$.

Home Export Supply (continued) For relative prices above $^1/_2$, Home exports more than 50 bushels, along the segment $B'C'$. For example, at the relative price of $^2/_3$, Home exports 60 bushels of wheat.

Foreign Import Demand Curve

FIGURE 2-10 (1 of 2)

(a) Foreign Production and Consumption

(b) Foreign Import Demand for Wheat

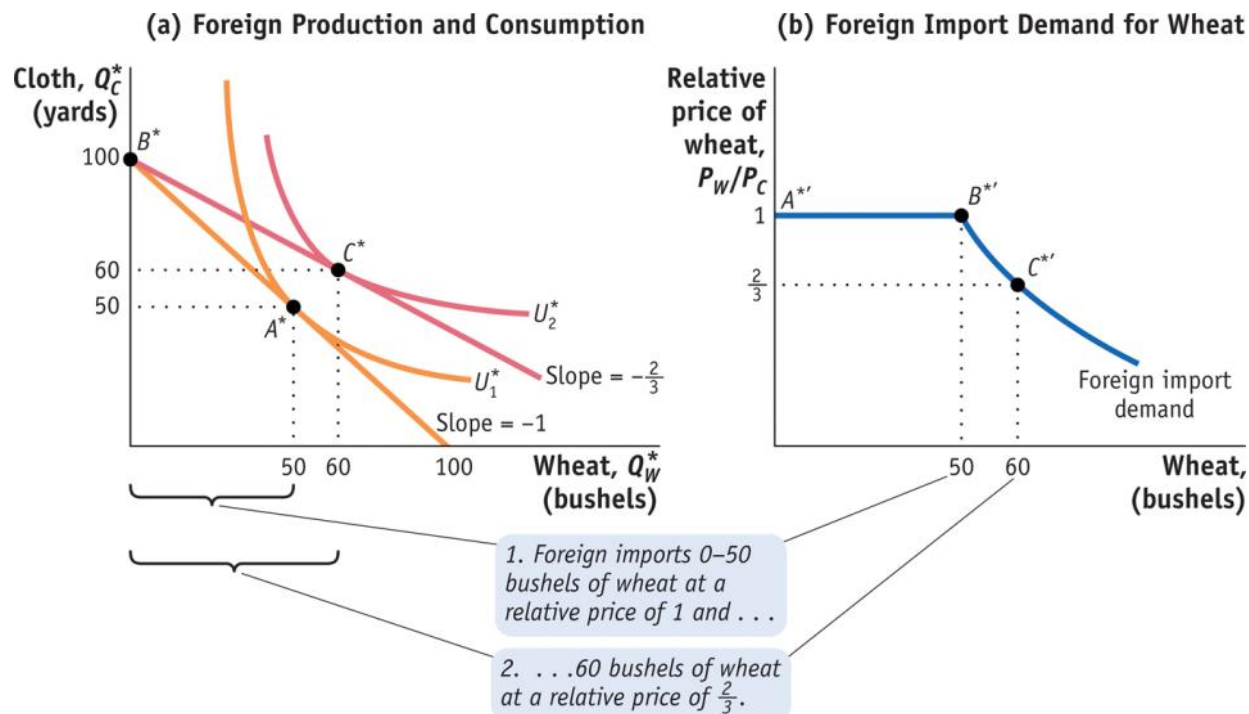1. Foreign imports 0–50 bushels of wheat at a relative price of 1 and . . .

Foreign Import Demand Panel (a) repeats Figure 2-6. Panel (b) shows Foreign import demand for wheat. When the relative price of wheat is 1, Foreign will import any amount of wheat between 0 and 50 bushels, along the segment $A^* B^{*\prime}$ of the Foreign import demand curve.

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Foreign Import Demand Curve

FIGURE 2-10 (2 of 2)

(a) Foreign Production and Consumption

(b) Foreign Import Demand for Wheat

1. Foreign imports 0–50 bushels of wheat at a relative price of 1 and . . .
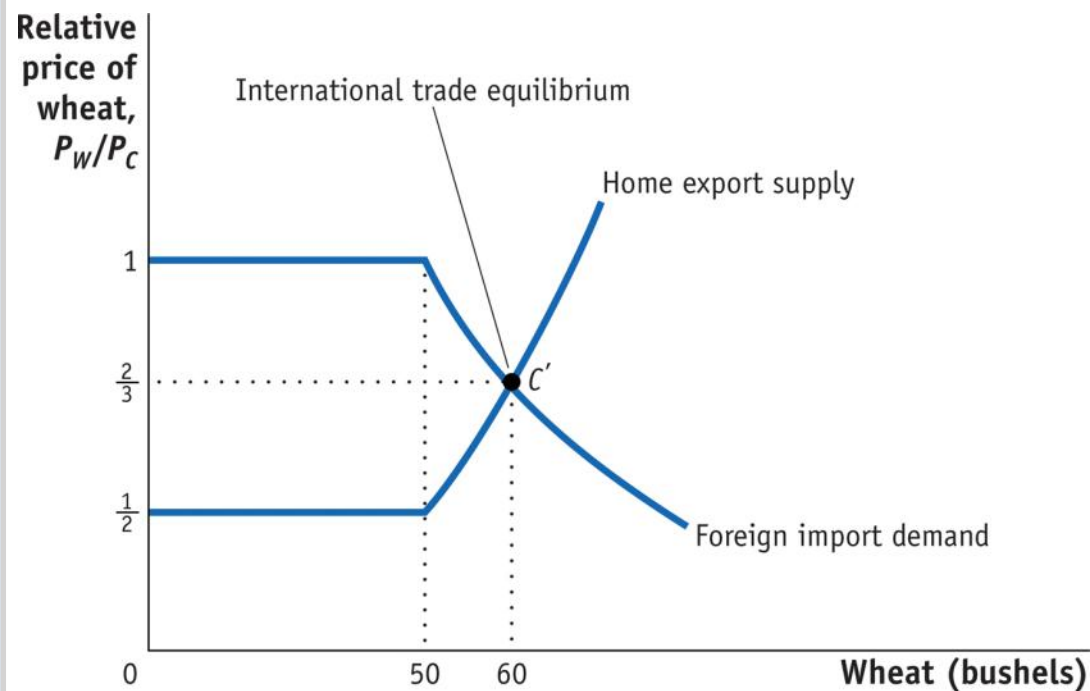
2. . . .60 bushels of wheat at a relative price of $\frac{2}{3}$.

Foreign Import Demand (continued) For relative prices below 1, Foreign imports more than 50 bushels, along the segment $B^{*\prime}C^{*\prime}$. For example, at the relative price of $^2/_3$, Foreign imports 60 bushels of wheat.

4 Solving for International Prices

International Trade Equilibrium

FIGURE 2-11

World Market for Wheat Putting together the Home **export supply curve** and the Foreign import demand curve for wheat, the world equilibrium is established at point C', where the relative price of wheat is $^2/_3$.

International Trade Equilibrium

The Terms of Trade

The price of a country's exports divided by the price of its imports is called the terms of trade.

- Because Home exports wheat, (P_W/P_C) is its terms of trade.

- Foreign exports cloth, so (P_C/P_W) is its terms of trade.

- In this case, having a higher price for cloth (Foreign's export) or a lower price for wheat (Foreign's import) would make the Foreign country better off.

The Terms of Trade for Primary Commodities

Economists Raúl Prebisch and Hans Singer argued that the price of primary commodities would decline over time relative to the price of manufactured goods.

Support for Hypothesis

- As people/countries become richer, they spend a smaller share of their income on food.

- For mineral products, industrialized countries continually find substitutes in the production of manufactured products.

Evidence Against Hypothesis

- Technological progress in manufactured goods can certainly lead to a fall in the price of these goods as they become easier to produce.

- At least for oil, the cartel restricting prices has caused an increase in the terms of trade for oil-exporting countries.

APPLICATION

The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel a)

(a) Relative Price of Primary Products (decreasing over time)
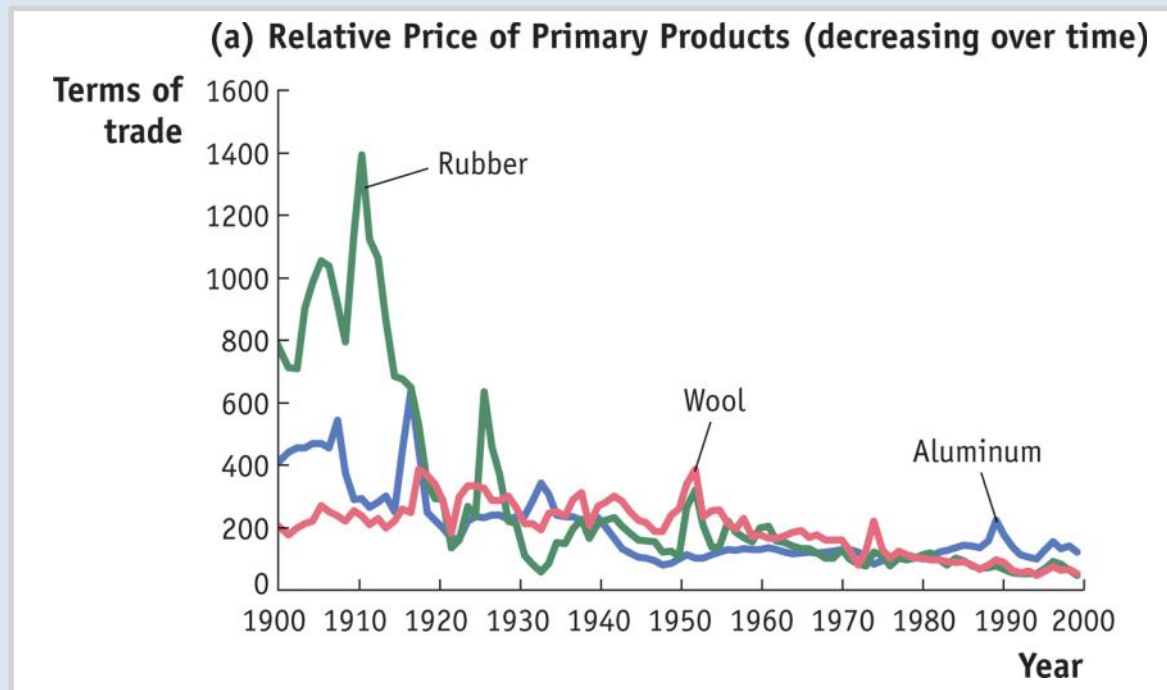
Relative Price of Primary Commodities Shown here are the prices of various primary commodities relative to an overall manufacturing price, from 1900 to 1998. The relative prices of some primary commodities have fallen over time (panel a)…

APPLICATION

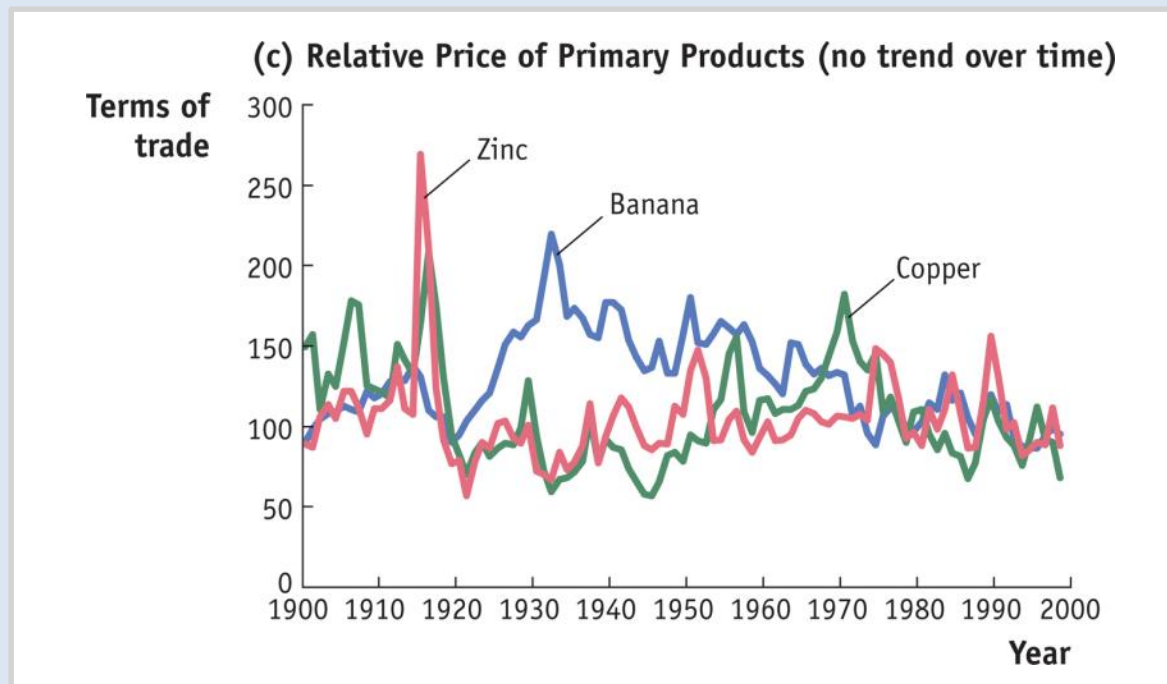## The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel b)

(b) Relative Price of Primary Products (increasing over time)
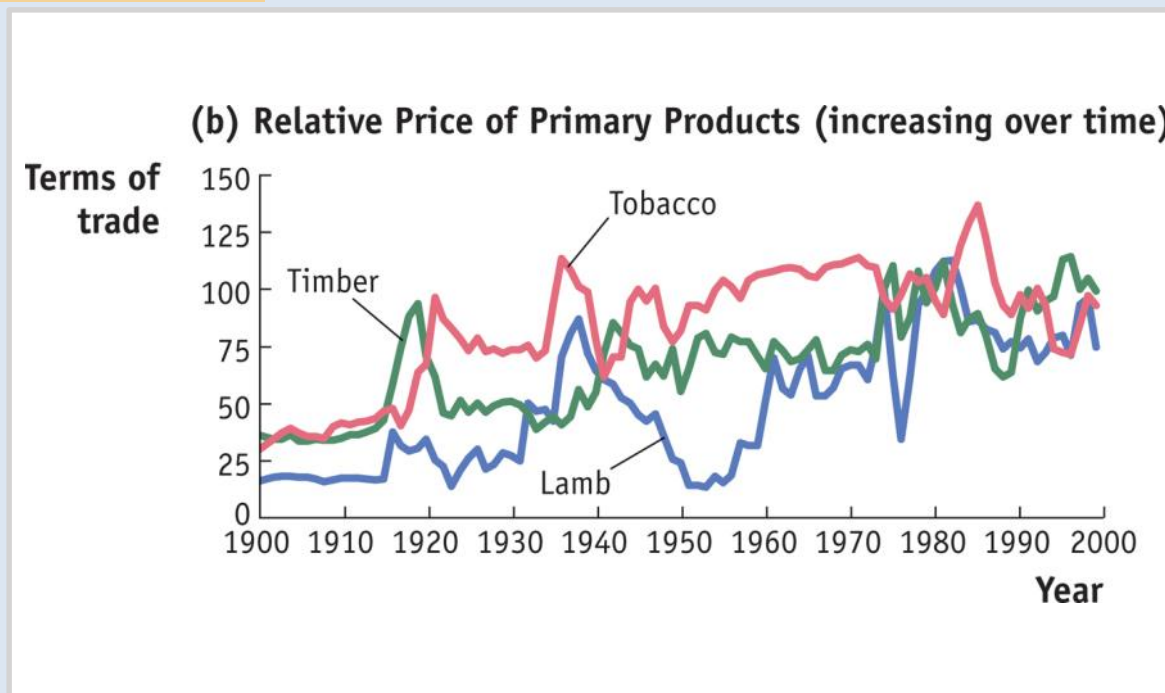
Relative Price of Primary Commodities … whereas other commodities have had rising relative prices (panel b)…

The Terms of Trade for Primary Commodities

FIGURE 2-12 (Panel c)

(c) Relative Price of Primary Products (no trend over time)

Relative Price of Primary Commodities … Other commodity prices show no consistent trend over time (panel c).