

Review of Production Theory: Chapter 2

Why?

Understand the determinants of what goods and services a country produces efficiently and which inefficiently.

Understand how the processes of a market economy produces outcomes (allocations), and whether or not they are efficient outcomes.

Understand general-equilibrium relationships, such as the relationship between barriers to trade, and the domestic distribution of income.

1. The production possibility frontier

Position:

- (1) factor endowments
- (2) real factor productivities

Slope:

- (1) relative factor productivities
- (2) factor endowments

Curvature:

- (1) constant returns to scale
- (2) factor intensity effects
- (3) increasing returns to scale

2. Equilibrium for a single competitive producer

Value of product = factor price

3. The Edgeworth Box

Contract curve, efficient allocations

Contract curve maps into PPF

Competitive equilibrium implies production efficiency
(production point is on the PPF)

4. Competitive equilibrium

Establish that a competitive equilibrium is a tangency between the PPF and equilibrium prices.

The Production Possibilities Frontier:

Summarizes information about:

A country's absolute ability to produce goods

A country's relative ability to produce goods

Suppose that there is just one factor of production, labor.

$$X = F_x(L_x)$$

$$Y = F_y(L_y)$$

$$\bar{L} = L_x + L_y$$

Assume constant returns to scale

$$X = \alpha L_x$$

$$Y = \beta L_y$$

where α and β are some positive constants.

Note that α and β are the *marginal products of labor* in industries X and Y respectively.

α and β give the additional outputs obtained from one unit of labor.

What happens as we move labor between sectors?

$$\Delta X = \alpha \Delta L_x$$

$$\Delta Y = \beta \Delta L_y = -\beta \Delta L_x \quad \text{since} \quad \Delta L_y = -\Delta L_x$$

$$\frac{\Delta Y}{\Delta X} = -\frac{\beta \Delta L_x}{\alpha \Delta L_x} = -\frac{\beta}{\alpha} \equiv MRT$$

MRT stands for the *marginal rate of transformation*: the ability of the economy to “transform” one good into the other.

The MRT is the slope of the production frontier.

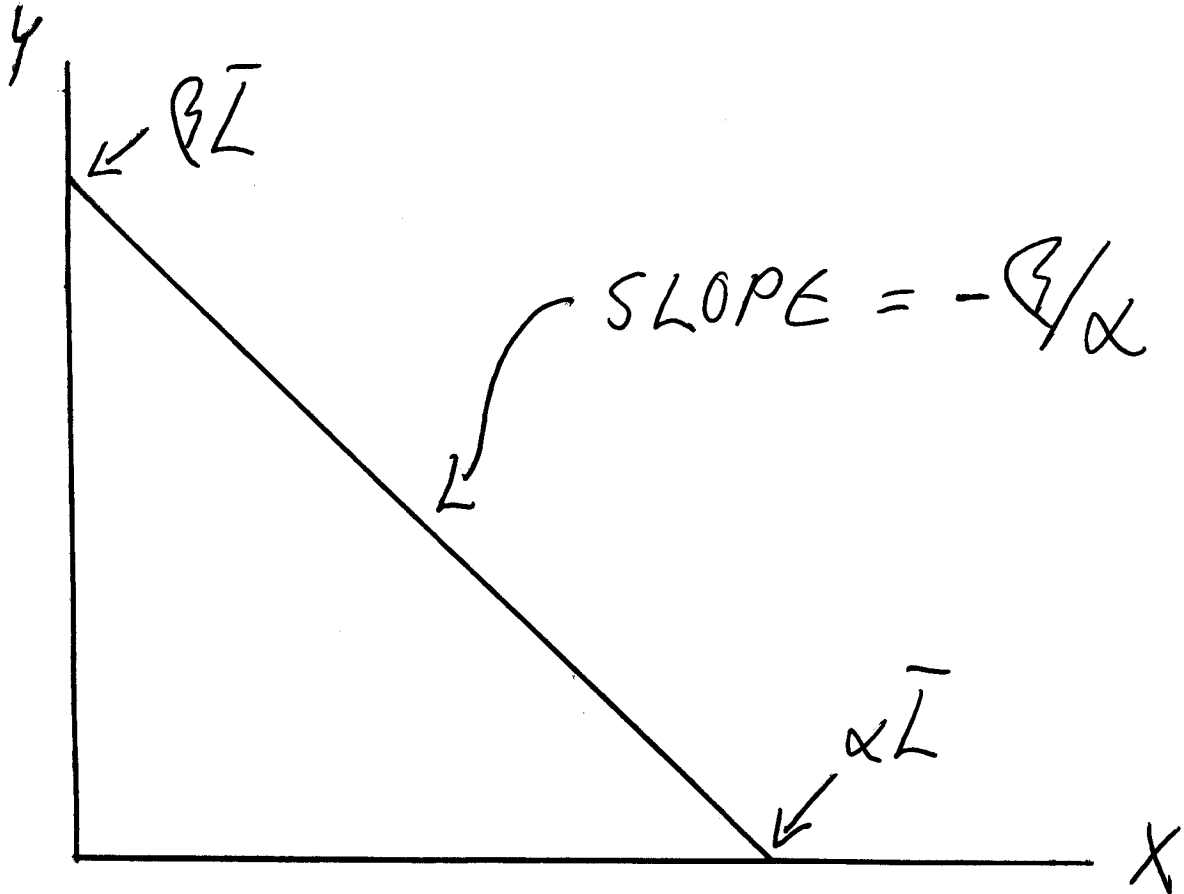
The slope is the ratio of the marginal productivities of labor in the two sectors.

In the special case where

- (a) there is only one factor of production
- (b) there are constant returns to scale

The production frontier is *linear*.

The production possibilities frontier



The “Economic Size” of the country (absolute ability to produce X and Y) is determined by:

- (a) The size of the labor force
- (b) The absolute productivity levels of labor

The country’s *relative* ability to produce X and Y is determined by:

The *ratio* of the labor productivities

The Role of factor endowments.

Suppose each good uses a second factor. X uses labor and land (R) and Y uses labor and capital (K).

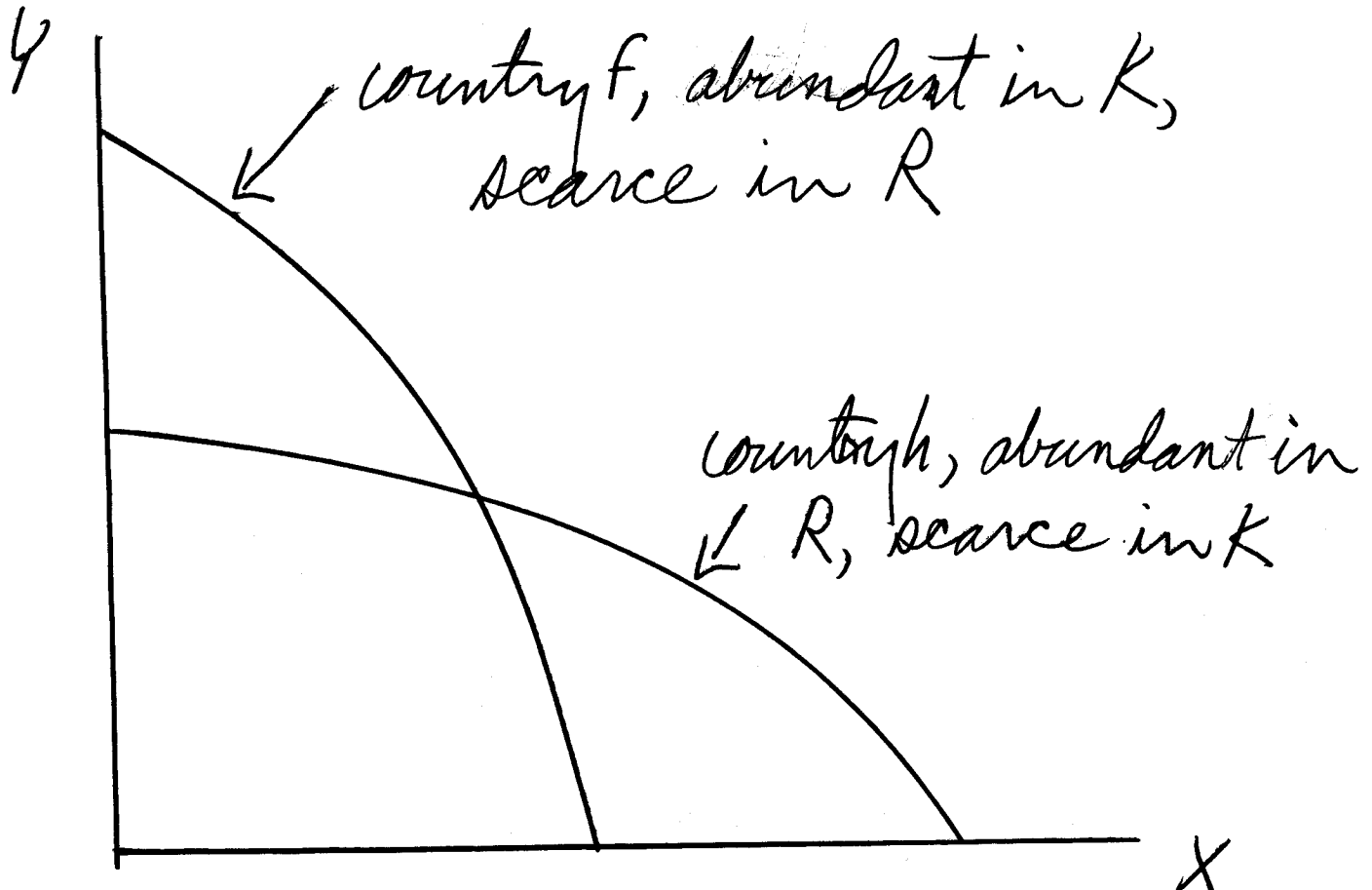
R is of no use in Y and K is of no use in X.

$$X = F_x(L_x, R)$$

$$Y = F_y(L_y, K)$$

$$\bar{L} = L_x + L_y$$

Suppose that we have two countries, h (home) and f (foreign). Both countries have the same endowments of L but h has more R, and f has more K (e.g., US and Japan).



Summary:

The slope of a country's production possibility frontier will depend on:

- (1) *Relative* factor productivities in the two industries.
- (2) *Relative* factor endowments.

A country will be better at producing good X if it has a

- (1) Relatively better technology (factor productivity) for X
- (2) Relatively better endowed with the factors used intensively in producing X

Why do we care?

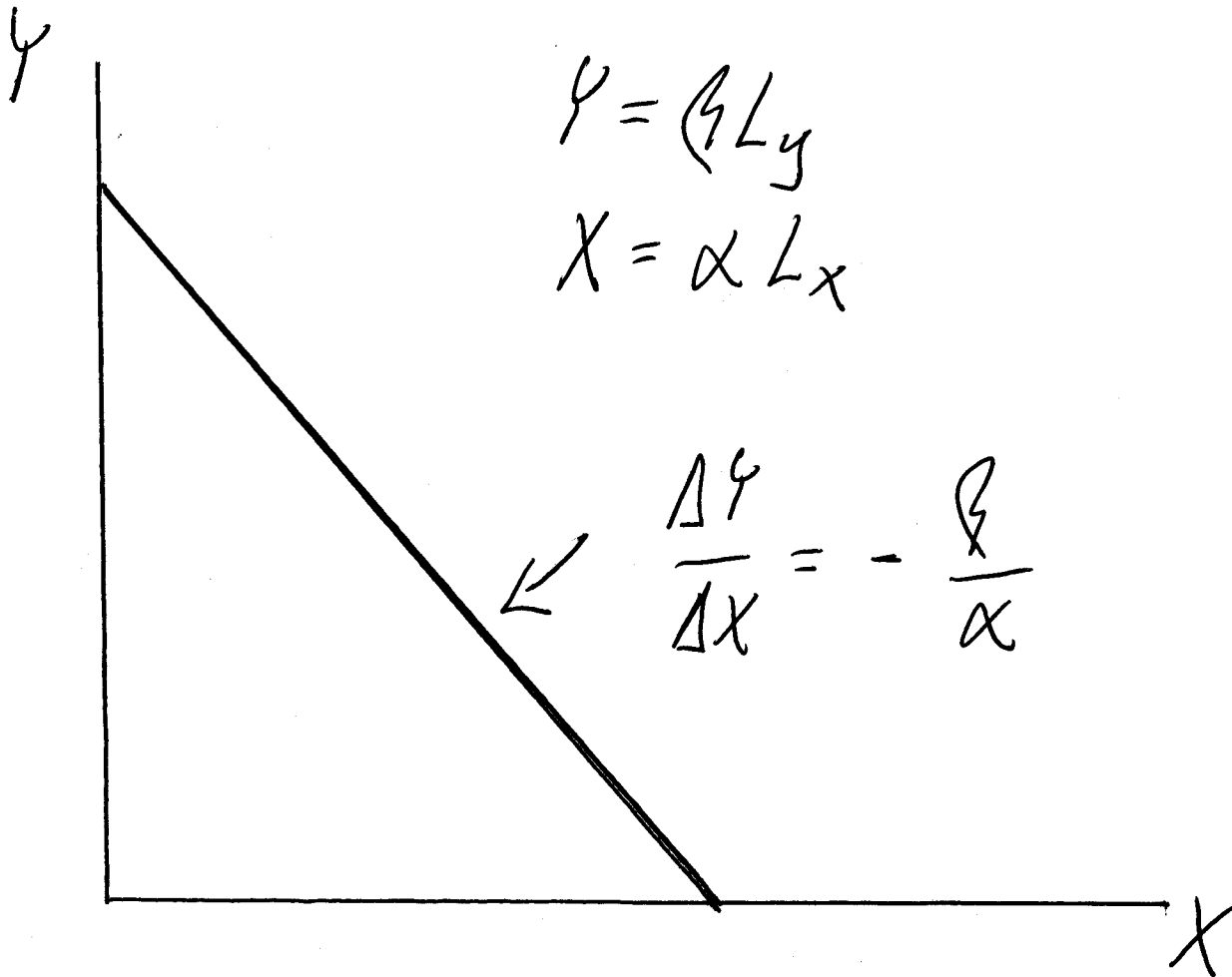
The differences in the slopes of the production frontiers determine the optimal direction of specialization and trade.

Curvature of the Production Possibilities Frontier

Important for:

- (1) the extent to which countries will specialize in trade
- (2) the extent to which very similar countries can gain from trade.

Case 1: Constant returns to scale, only one factor
Production frontier is linear



Case 2: Constant returns to scale, more than one factor, industries differ in *factor intensities*.

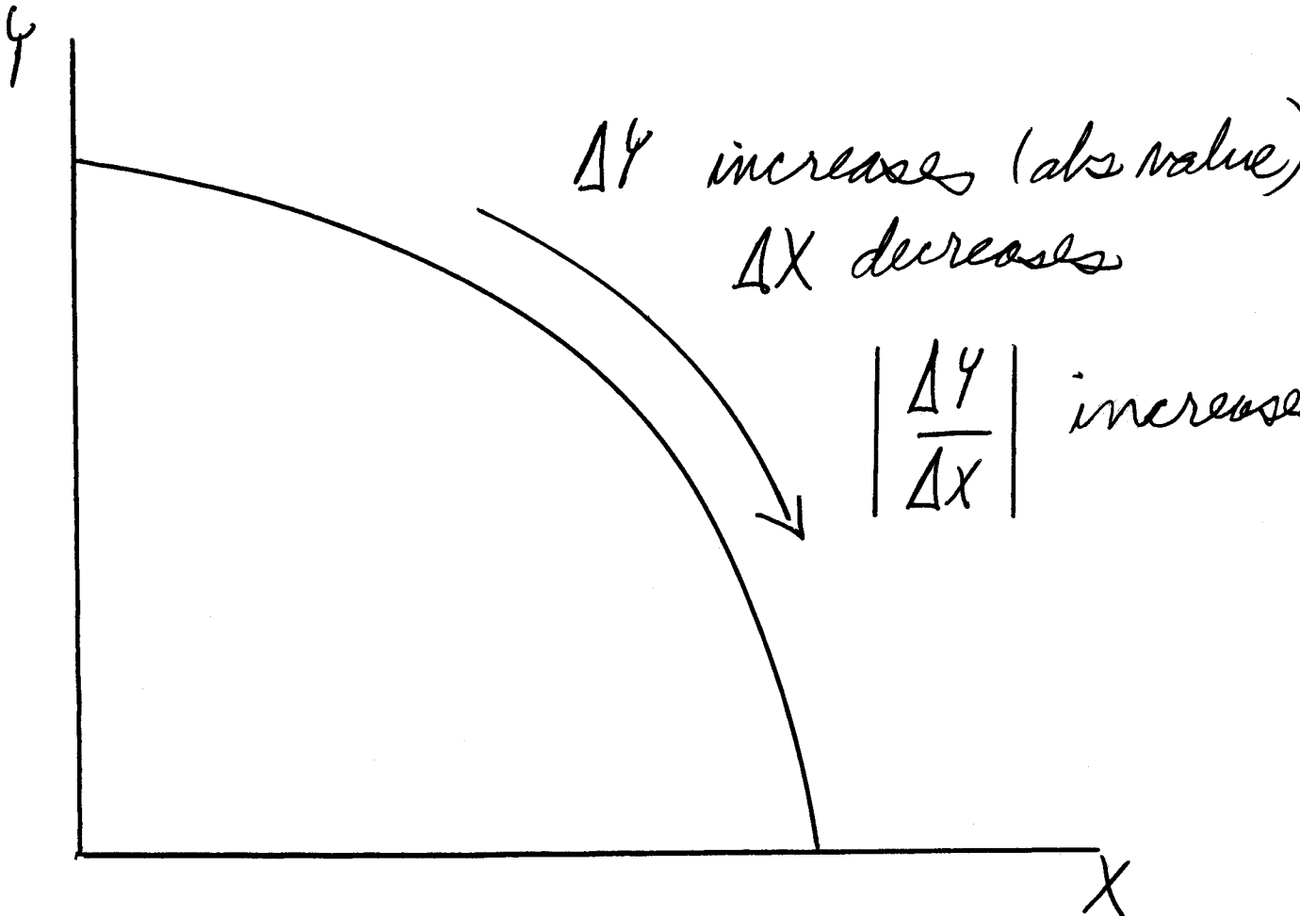
Production frontier is “bowed out”

$$X = F_x(L_x, R)$$

$$Y = F_y(L_y, K)$$

Law of diminishing marginal product

Adding additional units of a variable factor to a fixed factor results in smaller and smaller incremental units of output.



Case 3: Increasing returns to scale, one factor

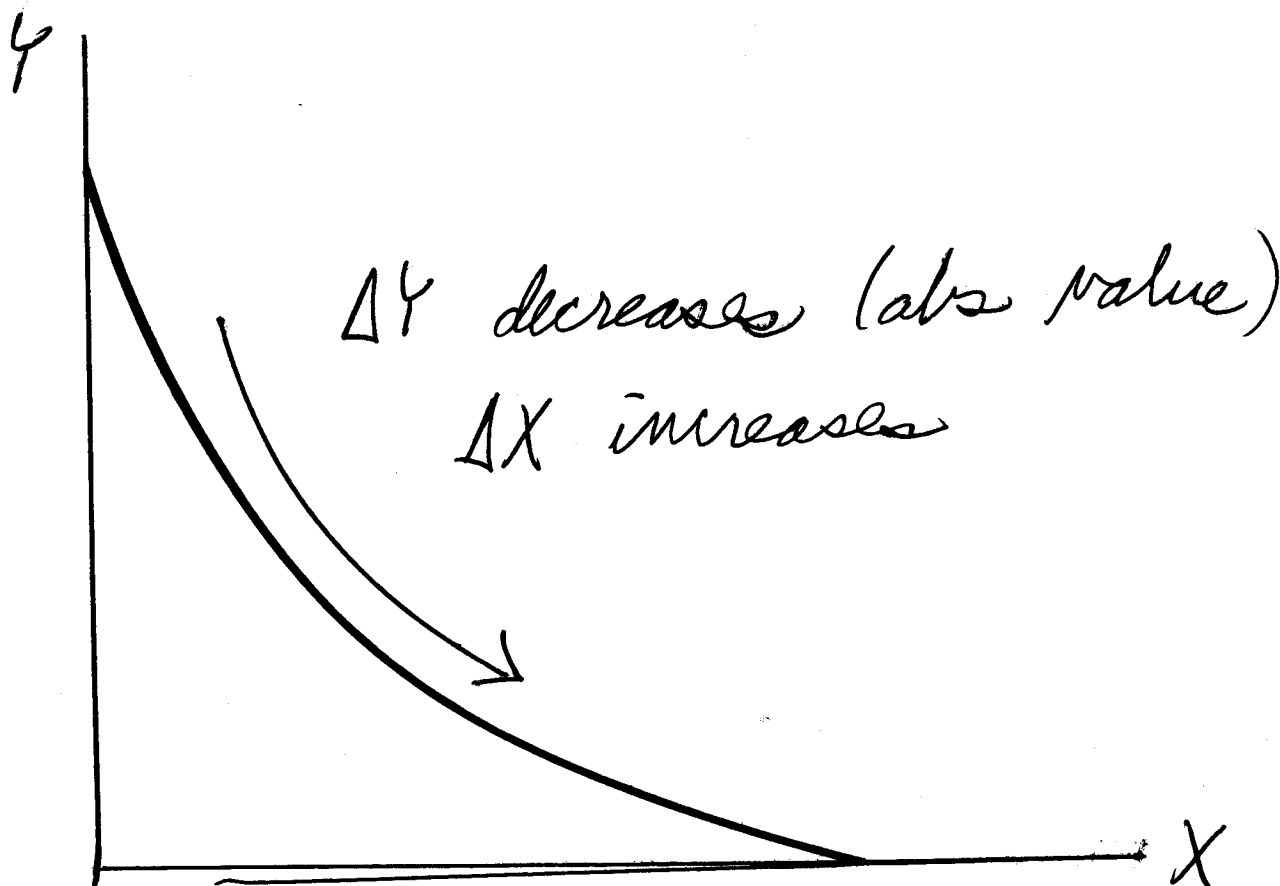
Production frontier is "bowed out"

$$X = L_x^2$$

$$Y = L_y^2$$

$$\frac{\Delta Y}{\Delta X} = \frac{2L_y \Delta L_y}{2L_x \Delta L_x} = -\frac{L_y}{L_x} \equiv MRT$$

As we move labor from Y to X (move down the production frontier), we get smaller and smaller decreases in Y output, and larger and larger increases in X output.



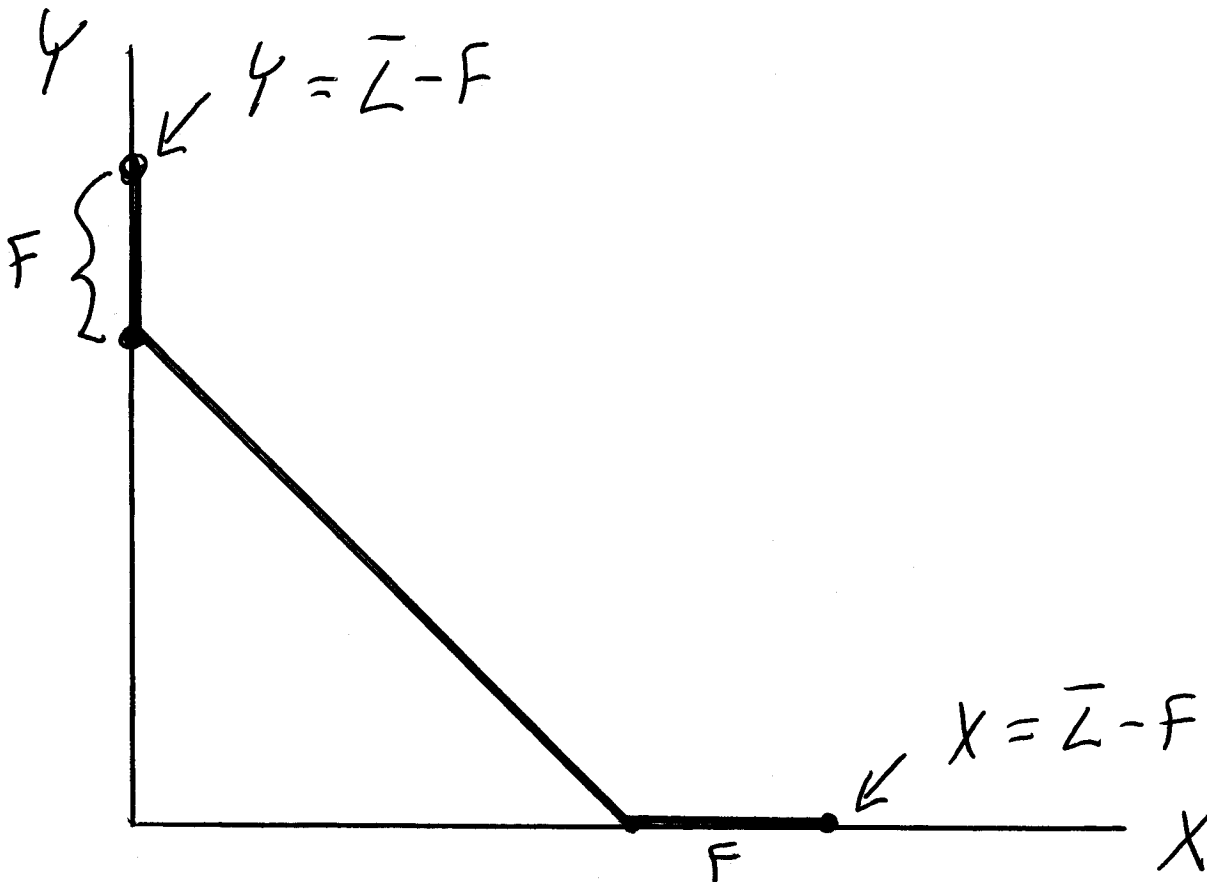
Alternative representation of scale economies:

There are fixed costs needed to begin producing X and Y

$$X = L_x - F$$

$$Y = L_y - F$$

$$\bar{L} = L_x + L_y$$



This is qualitatively similar to the previous case: Points mid way between the endpoint of the production frontier are not feasible production points.

The Edgeworth Box:

A popular simple model of trade based on differences in relative factor endowments between countries assumes that there are two goods and two factors.

Each factor is used in both goods. Goods may differ in *factor intensities*.

$$X = F_x(L_x, K_x)$$

$$Y = F_y(L_y, K_y)$$

$$\bar{L} = L_x + L_y$$

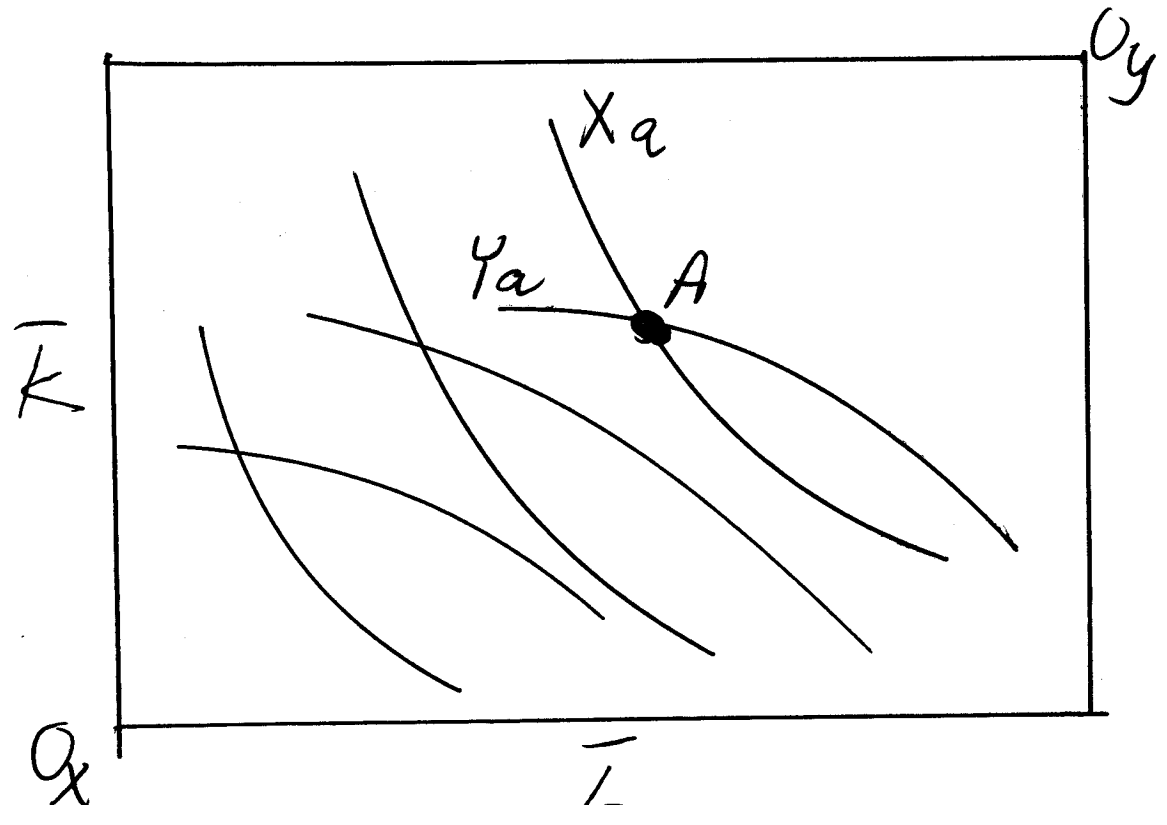
$$\bar{K} = K_x + K_y$$

The factor market side of an economy can be represented by an Edgeworth Box.

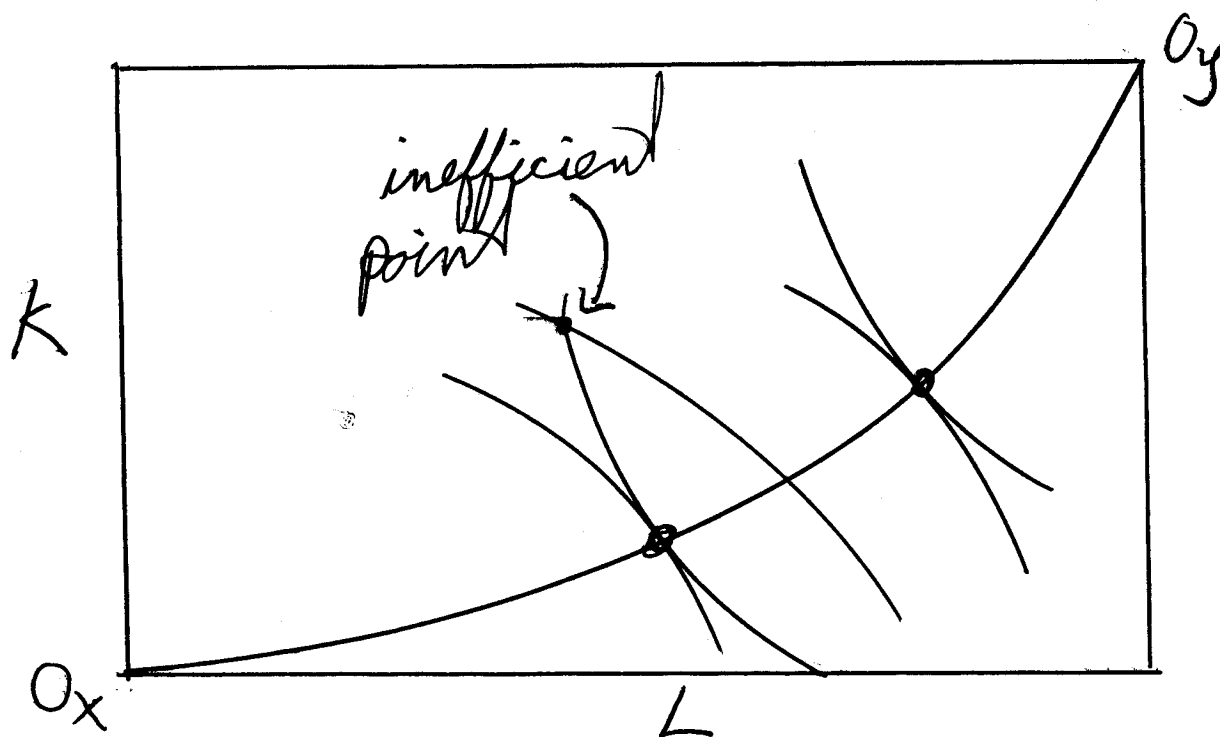
The vertical dimension is the economy's total supply of capital, and the horizontal dimension is total supply (endowment) of labor.



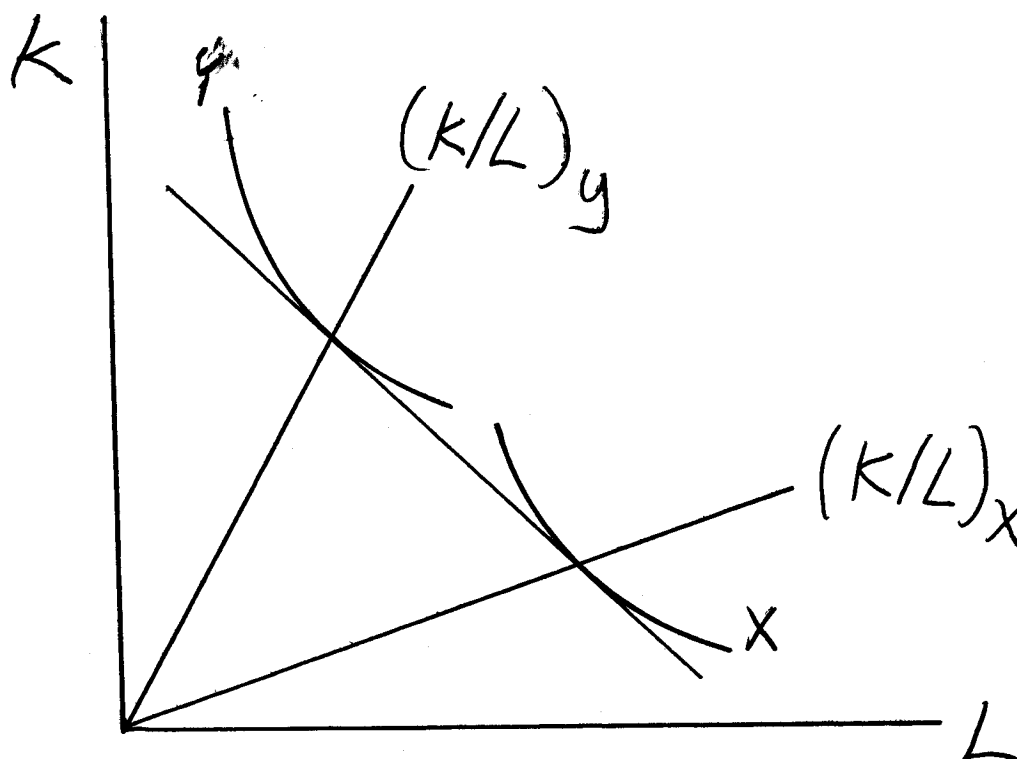
Each allocation implies outputs of X and Y



The locus of tangency points between Y and X isoquants is the locus of *Pareto efficient allocations*, called the *contract curve*.



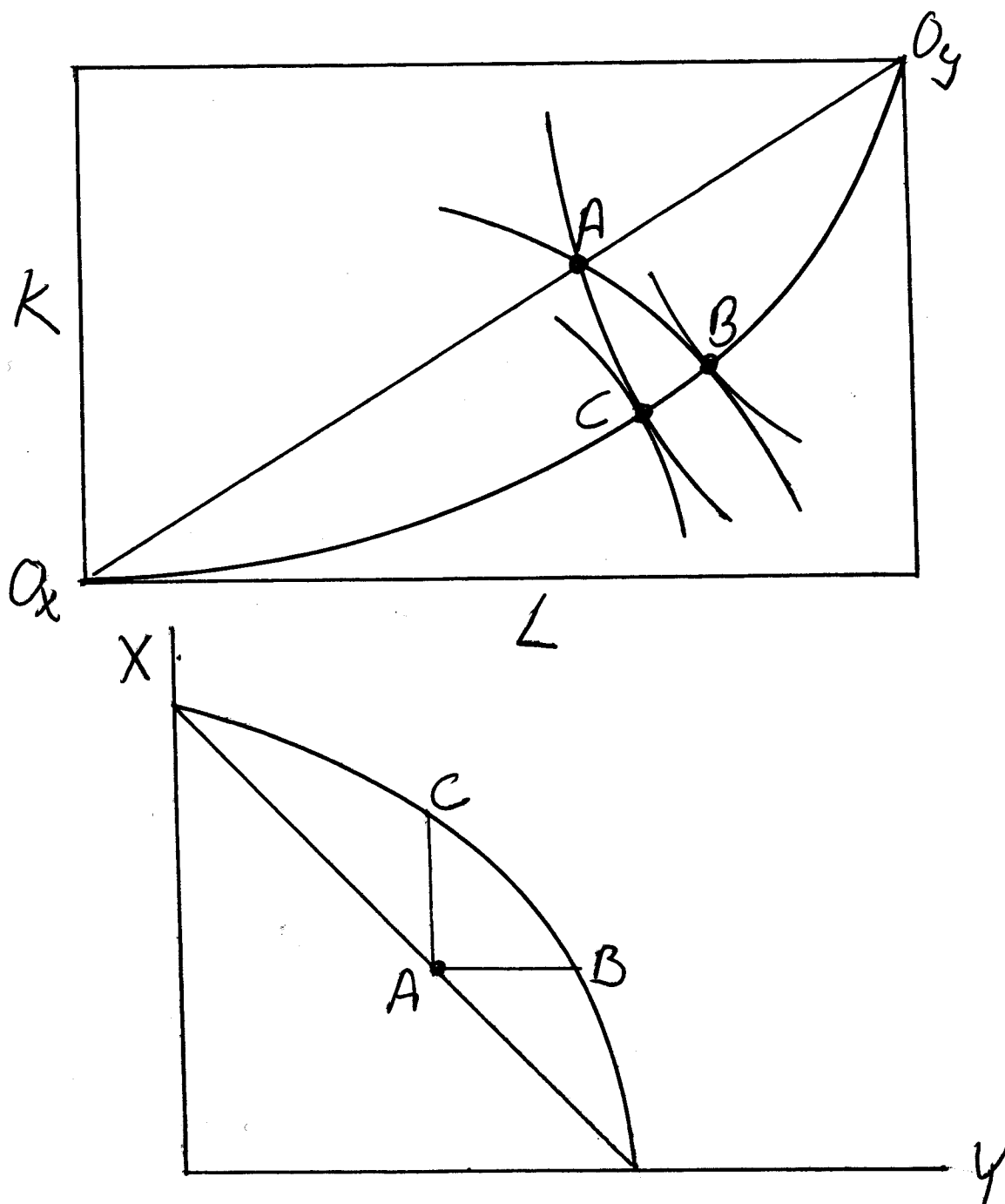
Good Y is said to be capital intensive if, as a given set of factor prices, the optimal K/L ratio in Y is greater than in X.



If goods differ in factor intensities, then the production frontier is "bowed out".

Point "A" in the factor box is on the diagonal of the production frontier.

But point "A" is not an efficient allocation, so it is not on the production frontier.



Summary:

A country's production frontier will be steeper (Y on the vertical axis) as

- (1) The country has relatively better technology in Y
- (2) The country is relatively well endowed with factors used intensively in the Y industry.

The curvature of the production frontier is:

- (1) Linear if there are constant returns and one factor (or many factors but no difference in factor intensities)
- (2) "Bowed out" if there are constant returns, more than one factor, and goods differ in relative factor intensities.
- (3) "Bowed in" if there are increasing returns to scale and one factor.

Competitive Equilibrium:

How does the market economy move from the 3 primitives: technology, factor endowments, etc. and come to an outcome (allocation).

An important question is whether or not the market economy does this *efficiently*, or if there is a need for government intervention.

Two goods, X and Y

Goods prices are p_x and p_y

Two factors, L and K

Factor prices are w (labor) and r (capital)

- (1) In competitive equilibrium, firms hire factors up to the point where the value of the marginal product of a factor equals its price

The value of marginal product is the price of output times physical marginal product.

$$p_x MP_{LX} = w$$

$$p_x MP_{KX} = r$$

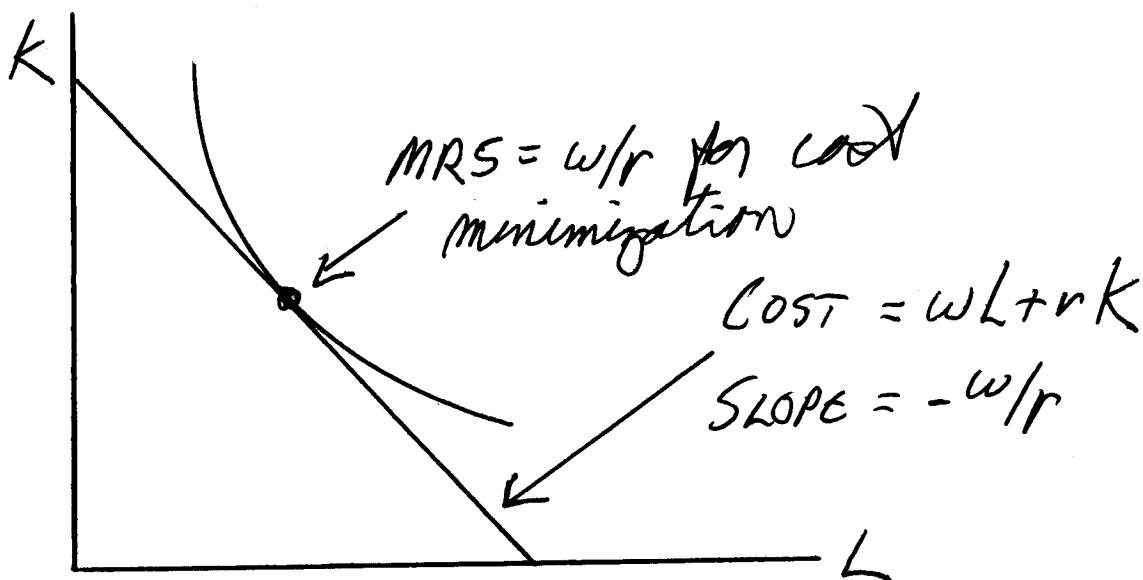
$$p_y MP_{LY} = w$$

$$p_y MP_{KY} = r$$

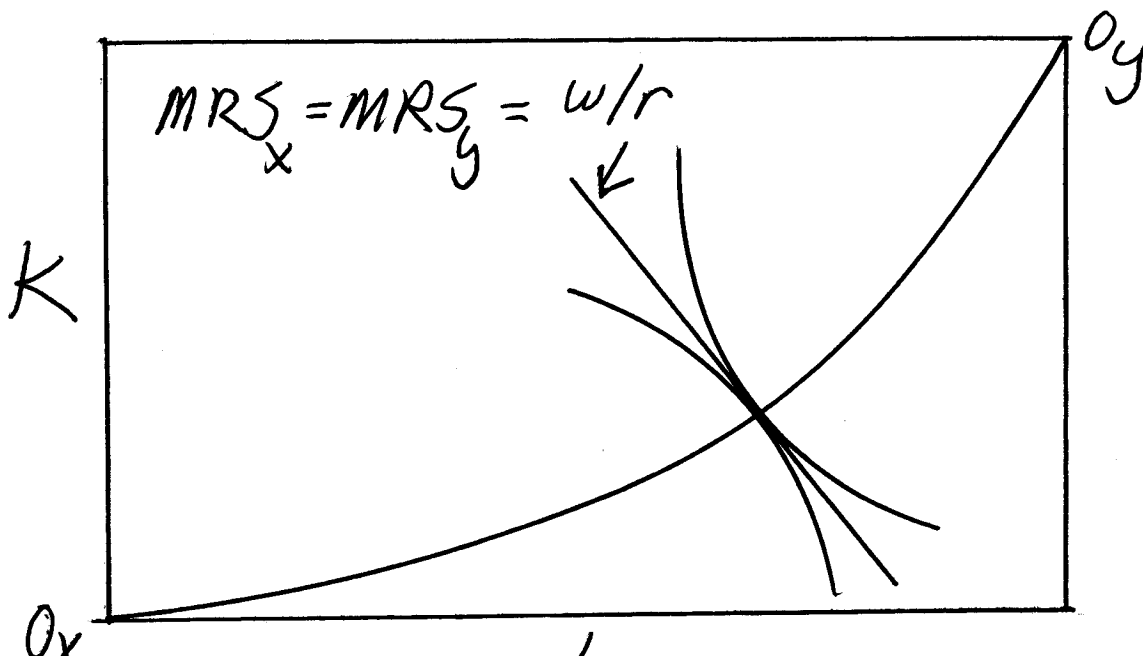
Dividing the first equation in each line by the second:

$$\frac{MP_{LX}}{MP_{KX}} = \frac{MP_{LY}}{MP_{KY}} = MRS = \frac{w}{r}$$

- (2) The ratio of marginal products (MRS) = the ratio of factor prices.



- (3) If all producers are competitive and face the same factor prices, then production is efficient (on the contract curve).



But what point on the PPF is chosen?

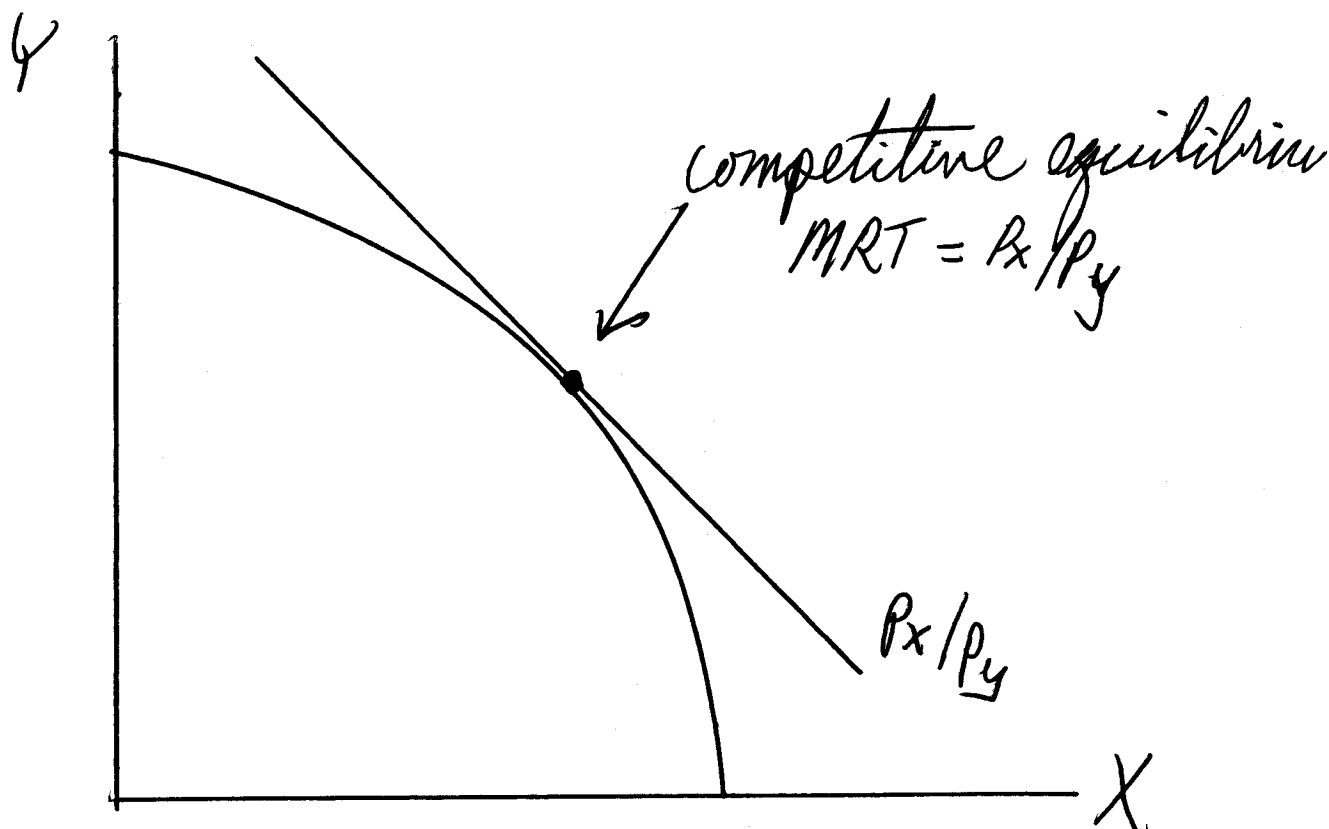
(4) Again use the value-of-marginal-product conditions

$$\frac{p_x MP_{LX}}{p_y MP_{LY}} = \frac{w}{w} \Rightarrow \frac{p_x}{p_y} = \frac{MP_{LY}}{MP_{LX}}$$

$$\frac{p_x}{p_y} = \frac{\Delta Y / \Delta L_y}{\Delta X / \Delta L_x} = - \frac{\Delta Y / \Delta L_x}{\Delta X / \Delta L_x} = - \frac{\Delta Y}{\Delta X} = MRT$$

(5) At any given commodity prices, production is efficient.

This is Adam Smith's "invisible hand" of the market



What should you know?

- (1) How the slope of a country's production frontier depends on its technology and its factor endowments**

- (2) How the curvature of the production frontier depends on**
 - (a) factor endowments**
 - (b) returns to scale**

- (3) At given prices, undistorted competitive economies produce efficiently.**

this depends on:

- (a) competition in all markets**
- (b) all firms face the same, true factor prices**
- (c) all firms face the same true output prices**
- (d) no externalities**

(don't worry, we will spend lots of time on imperfect competition, distortions, taxes, and externalities)