Chapter 12
General Equilibrium and Welfare

Up to this point we have dealt with only <u>one market</u> at a time; **Partial Equilibrium Models**. Logic suggests that markets are highly <u>interconnected</u>. What happens in one market <u>affects many others</u>. In the extreme, the adjustments in other markets may <u>come full circle</u> and affect the original market. Nothing happens in isolation. The whole economy is <u>simultaneously related</u>. We need a model that allows the interconnectedness of markets in contrast to Partial Equilibrium Models. We need a simultaneous perspective.

The General Equilibrium Model outlined below helps us develop hypotheses about the real world. The model is an abstraction from reality that helps us understand the real world.

Perfectly Competitive Price System

Assumed:

A set of perfectly competitive markets exists for inputs and outputs.

Each market has an equilibrium price.

Equilibrium prices clear the markets.

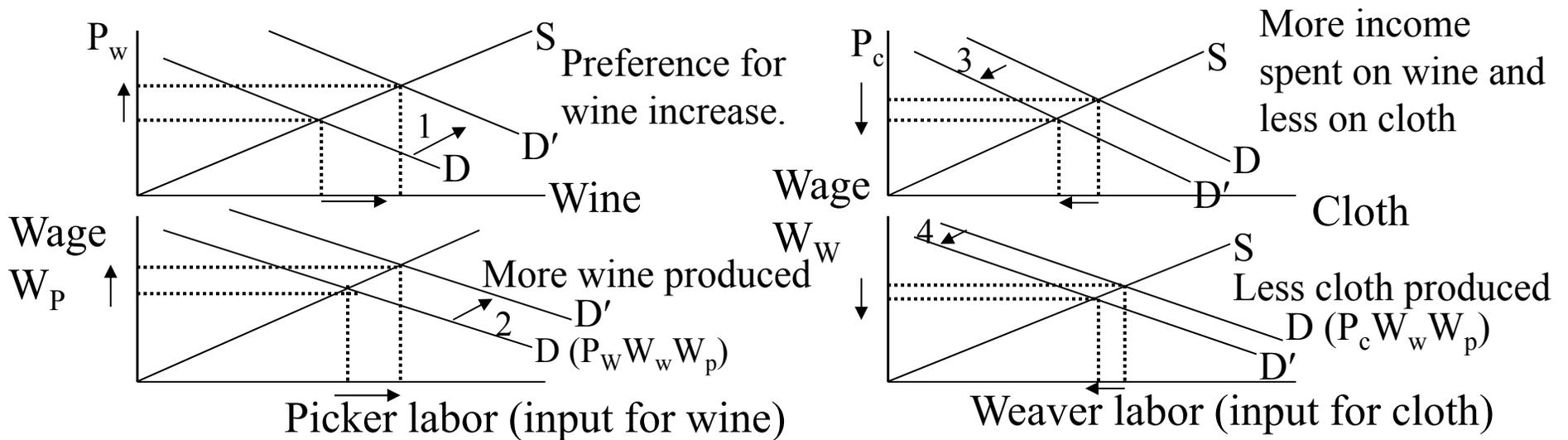Zero transaction costs.

Perfect knowledge.

No transportation costs.

The Law of One Price – Each good and input obeys this law, which is that the good or input is homogeneous and sells for the same price to everyone in all markets. Arbitrage assures one price.

All consumers are rational price takers both as buyers of goods and sellers of inputs (eg., labor). Each market has a very large number of utility-maximizing consumers for any one good or input.

All firms are rational price takers in both input and output markets. Each market has a very large number of profit-maximizing firms producing each homogeneous good or input.

If all markets follow the above assumptions, we can analyze general equilibrium. For example:

P_w S
Preference for wine increase.
1
D′
D
Wine

Wage
W_P
More wine produced
D′
2
D ($P_W W_w W_p$)
Picker labor (input for wine)

P_c 3 S
More income spent on wine and less on cloth
D
D′
Cloth

Wage
W_W
4
S
Less cloth produced
D ($P_c W_w W_p$)
D′
Weaver labor (input for cloth)

But the story could continue if unemployed weavers are trained to be grape pickers, increasing the supply of pickers, and because more pickers are available, the wage rate for pickers declines, increasing the supply of wine.

Also a decrease in the wage rate for weavers might decrease the demand for wine and cloth, while an increase in the wage rate for pickers might increase the demand for wine and cloth. And so on, and so on, etc.

Graphical Model of General Equilibrium (GE)
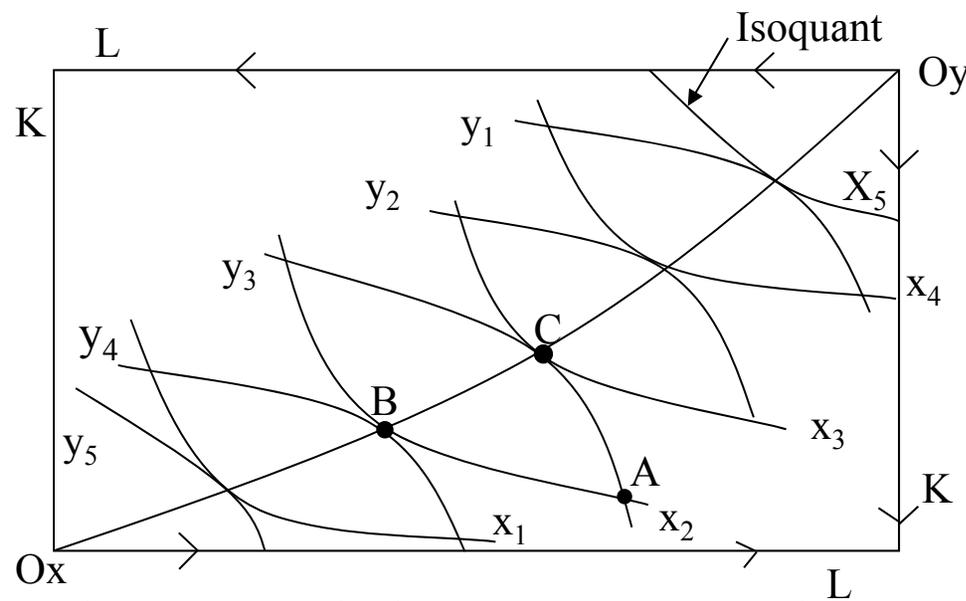
Demand in a GE model is represented by society's indifference curves for two goods (later).

Supply in a GE model for two goods (x and y) and two inputs (K and L) begins with use of the Edgeworth Box.

Labels in figure: L, K, Oy, Isoquant, y_1, y_2, y_3, y_4, y_5, X_5, x_4, x_3, x_2, x_1, C, B, A, Ox, K, L

- Any point in the box represents a combination of K and L used to produce each good (x and y), given technology.

- Each point represents full employment of K and L, and the amounts of K and L are fixed.

- An isoquant shows a given quantity of a good produced and the different combinations of K and L used to produce the given quantity. Each point is on an isoquant for x and for y.

- Points on the line, O_xO_y, are technically efficient in that movements away from the line involve less of x or y or less of both.

- **Point A is inefficient.** Points down the y_3 isoquant from point C toward point A give less x without changing y, while moving down the x_2 isoquant from point B toward point A gives less y without changing x. Movements from a point on O_xO_y between points B and C toward point A give less x and less y.

Production Possibility Frontier (PPF)

On the efficient line, O_xO_y, the RTS_{LK} are equal for x and y.

The efficient line O_xO_y where the $RTS_x = RTS_y$ shows the maximum amount of y (or x) that can be produced for the fixed amount of x (or y). Thus, we can take the information from the O_xO_y line and construct a production possibilities frontier (PPF).
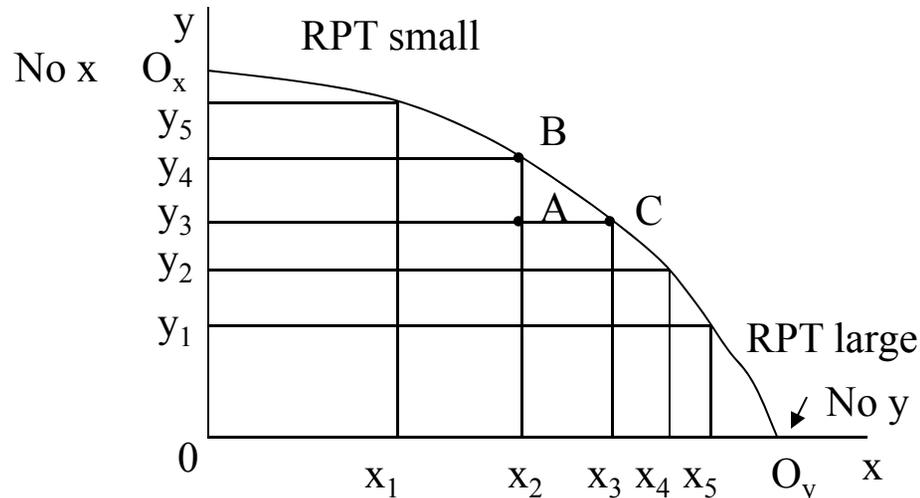
The PPF shows combinations of two outputs that can be produced with fixed quantities of inputs if the <u>inputs are fully and efficiently employed</u>. We got this PPF by transferring points along the O_xO_y line onto this graph. Points toward the origin from the PPF (eg., point A) are inefficient (off O_xO_y).

Rate of Product Transformation (RPT_{xy}) is the negative of the slope of the PPF and shows how x can be substituted for y with efficient use of fully employed inputs and total input quantities and technology constant. The RPT equals -dy/dx (the negative of the slope of the PPF). A curved PPF gives an increasing RPT_{xy}; a <u>concave</u> PPF.

The total cost function for society might be C = C(x,y), which would be constant along a PPF because of full employment and fixed input quantities.

Thus, the total differential $dC = \dfrac{\partial C}{\partial x} dx + \dfrac{\partial C}{\partial y} dy$ set to 0.

Manipulating, $\dfrac{\partial C}{\partial x} dx = -\dfrac{\partial C}{\partial y} dy \Rightarrow \dfrac{\partial C/\partial x}{\partial C/\partial y} = -\dfrac{dy}{dx} \Rightarrow \dfrac{MC_x}{MC_y} = RPT_{xy}$

The RPT is a measure of the relative marginal costs of the two goods. For example, if the RPT equals 2, MC_x equals $2MC_y$, so the economy must give up 2y to get 1x.

Opportunity Cost and the RPT – As x increases, MC_x increases and as y decreases, MC_y decreases, so the RPT increases, implying that the PPF is concave! If the RPT increases, the opportunity cost of x increases. As we get more x, the cost of getting an additional unit of x increases in terms of the amount of y that must be sacrificed.

Why would the PPF be concave?

1. One could argue that each good is produced under decreasing returns to scale. Then the MC of each good rises as its quantity rises. As x increases and y decreases, MC_x/MC_y increases. However, diminishing returns to scale are not ubiquitous.

2. If some units of K are better suited to x than other units of K, then MC_x would increase as x increases (as more costly K was used to produce x) and MC_y would decrease as y decreased (less costly K to produce y) and vice versa. For example, if a farmer increases cotton production and decreases corn production, more of the unproductive land will be used to produce cotton, increasing the MC of cotton and less unproductive land will be used to produce corn, decreasing the MC of corn. However, we have assumed homogeneous inputs, but this explanation could be a factor in the real world.

3. Concavity will exist if the two goods use K and L in different proportions at any point on O_xO_y. This occurs if O_xO_y is bowed above or below the diagonal. If bowed above, x is K-intensive relative to y. If bowed below the diagonal, y is K-intensive relative to x.
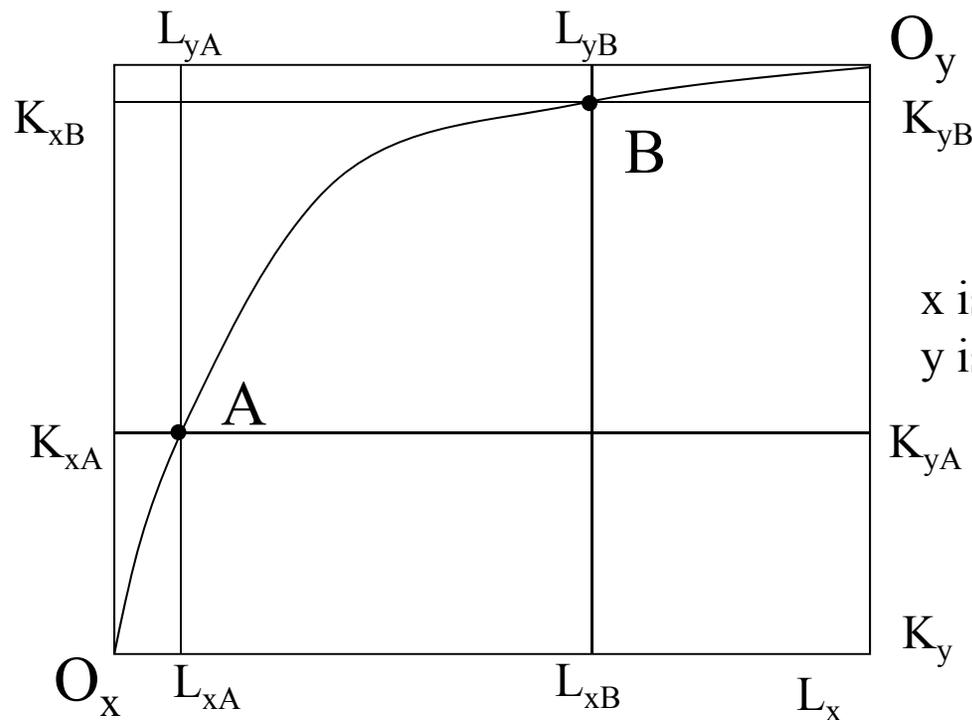
In the box above, the ratio of K/L is greater for x than for y at every point on O_xO_y. At point A, the K_{xA}/L_{xA} for x is large and the K_{yA}/L_{yA} for y is medium. At point B, the K_{xB}/L_{xB} for x is medium and the K_{yB}/L_{yB} for y is small. In going from A to B, the K/L declines for both x and y, causing MC_x to increase and MC_y to decrease, so $MC_x/MC_y = RPT$ increases. If O_xO_y is linear, the PPF is also linear.

The MC_x increases as x increases because an additional unit of x production causes the worst suited input (L) to increase at a faster rate than the best suited input (K). The opposite argument is used to explain why MC_y decreases as y decreases.
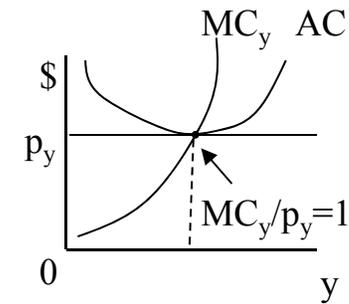
Equilibrium Price Determination in the GE Model

Combine PPF (representing supply) with Indifference Curves (representing demand). Generalize the discussion to all firms. Profit-maximizing firms in the absence of trade will choose x_1y_1 given the price ratio and RPT ($MC_x/MC_y = RPT_{xy} = p_x/p_y$).
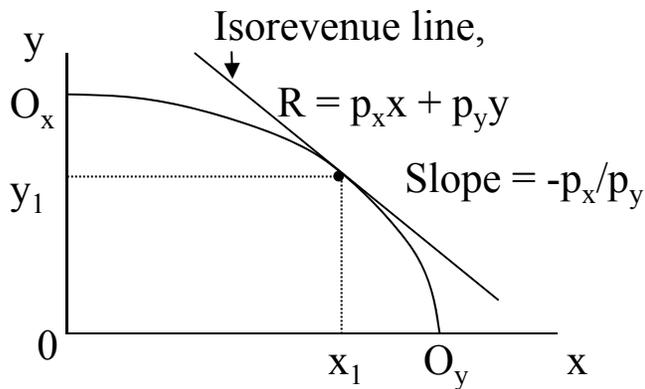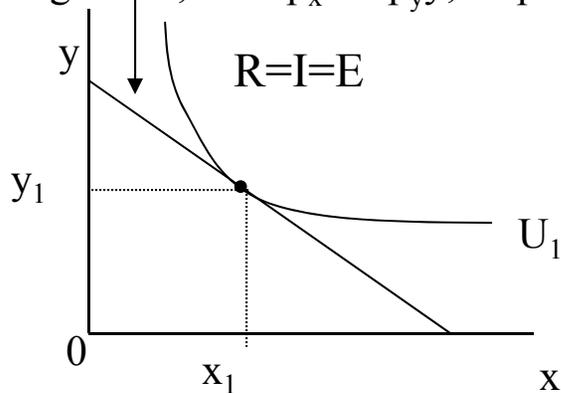
$$\frac{p_x}{p_y} = RPT_{xy} = \frac{MC_x}{MC_y}$$

or $\dfrac{MC_x}{p_x} = \dfrac{MC_y}{p_y} = 1$

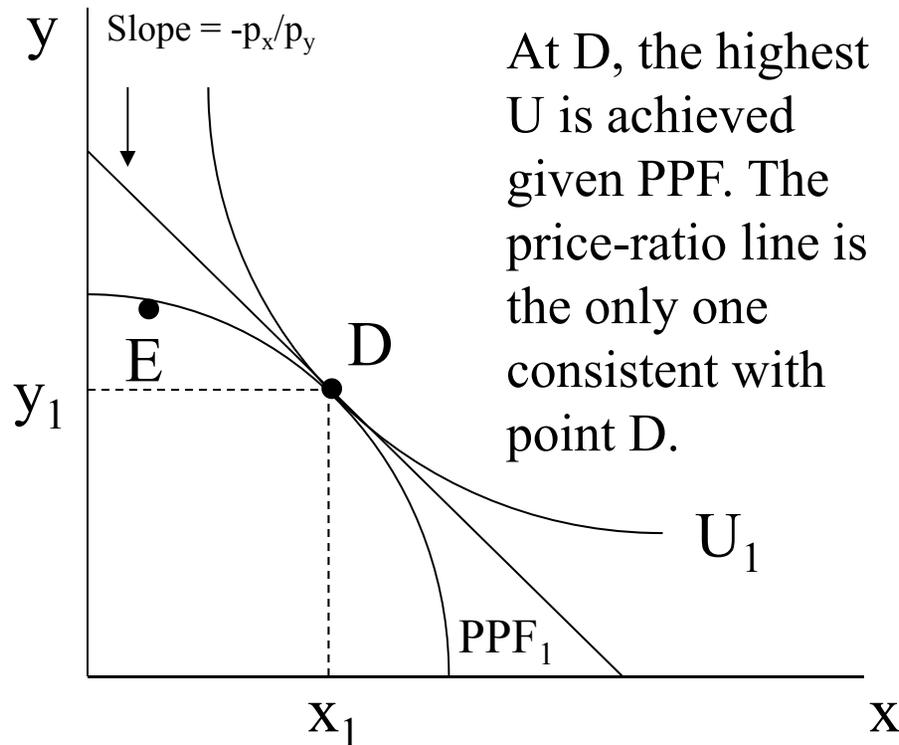The isorevenue line" shown in the graph is the highest attainable given PPF, p_x, and p_y.

Because $R = p_x x + p_y y$, and revenue is expenditures (=income) to consumers, this is the budget line for consumers.

Also remember that consumers will maximize utility by reaching highest indifference curve where $p_x/p_y = MU_x/MU_y = MRS_{xy}$.

Because we assume the same p_x/p_y exists for producers and consumers, we can combine the graphs to show a general equilibrium.

$$\text{At D, } MRS_{xy} = -\frac{dy^{Ind}}{dx} = \frac{MU_x}{MU_y} = \frac{p_x}{p_y} = \frac{MC_x}{MC_y} = -\frac{dy^{PPF}}{dx} = RPT_{xy}$$

Budget line and Isorevenue line

Slope = $-p_x/p_y$

At D, the highest U is achieved given PPF. The price-ratio line is the only one consistent with point D.

The ratio of MC's equals the ratio of MU's. x_1 and y_1 identify point D along O_xO_y in the Edgeworth Box. All inputs are used efficiently and fully employed.

Q_x demanded = Q_x supplied = x_1

Q_y demanded = Q_y supplied = y_1

Point D is the equilibrium because other points (say E) will induce tendencies toward D.

If p_x'/p_y' existed, firms would choose E, while consumers would choose F. MRS = RPT = p_x'/p_y', but excess demand for x ($x_2 - x_1$) and excess supply of y (y_1-y_2) exist, so these prices are not general equilibrium prices. They would not be stable; p_x would increase and p_y would decrease, rotating isorevenue line until it is tangent to Indifference curve U_1 and the PPF at D. Equilibrium for this two-good, two-input economy is established at D where $Q_{xD} = Q_{xS}$, $Q_{yD} = Q_{yS}$, and MRS = RPT = p_x/p_y.
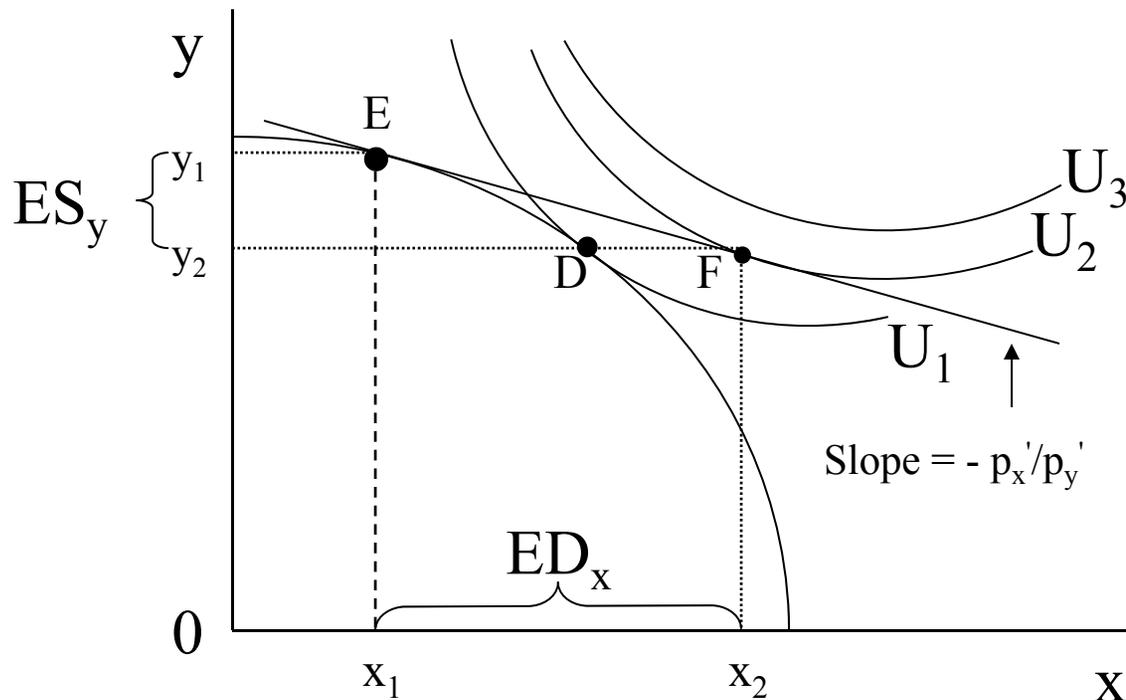
This analysis is extendable to many goods where firms are maximizing profit and consumers are maximizing utility. Markets are cleared by changes in p_x and p_y. Prices are the communicators and equilibrator! **The essence of equilibrium is that $Q_S = Q_D$ (for both goods) and MRS = RPT = p_x/p_y (two conditions if no trade).**

The two basic forces determining the equilibrium price ratio, Q_x, and Q_y are:
The **preference system** of consumers (indifference curves, demand) and
production technologies of the firms for x and y (isoquants, supply).
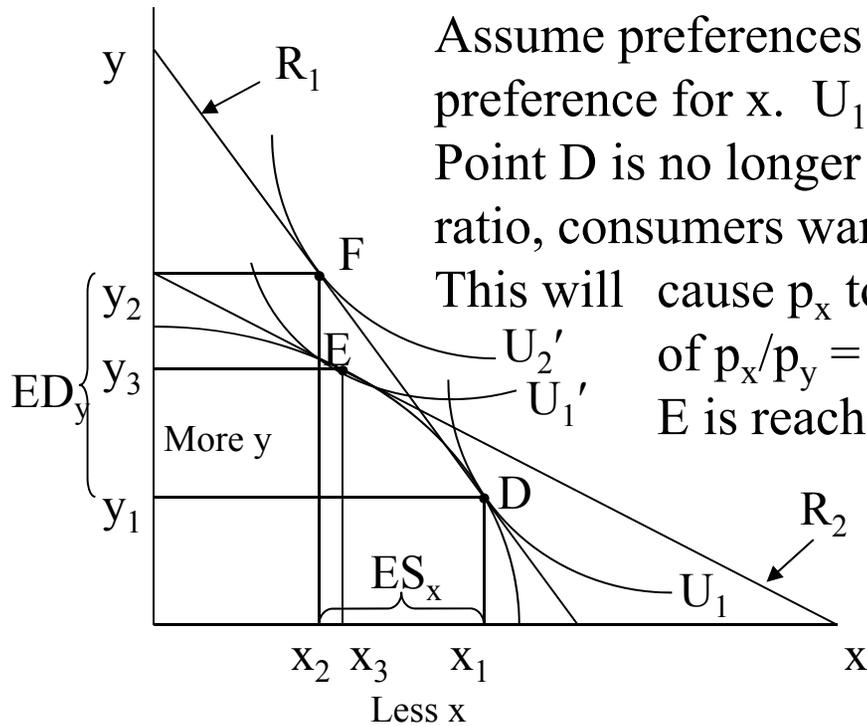
Assume preferences shift away from x toward y. U_1 shows a preference for x. U_1' and U_2' show a shift away from x. Point D is no longer an equilibrium point because at R_1 price ratio, consumers want point F ($Q_{xD} < Q_{xS}$ and $Q_{yD} > Q_{yS}$). This will cause p_x to decrease and p_y to increase. <u>Equalities</u> of p_x/p_y = MRS and p_x/p_y = PPF will change until E is reached. The result will be more y at a higher price and less x at a lower price. Consumers' desires were accommodated given the PPF constraint. This example assumes no trade. With trade an economy can be at point F, with higher utility.

y

R_1

F

y_2

E

U_2'

ED$\{$ y_3

U_1'

More y

y_1

D

R_2

ES_x

U_1

x_2 x_3 x_1

x

Less x

We could show a change in production technology as a shift in the PPF curve and trace changes to new equilibrium prices, production, and consumption. For example, assume a change in technology favoring x production, MC_x would decline, so the $RPT_{xy} = MC_x/MC_y$ would decline, causing p_x/p_y to decline also. Prices are determined jointly by utility functions and production functions. Graph this situation on your own.

Existence of General Equilibrium

Does a set of prices exist for which all markets are in equilibrium simultaneously?

- **Assume** a set of goods, $i = 1,2,3,\ldots,n$

- **Supply** of each good is fixed at S_i and distributed in some way among individuals

- **Demand** for each good is dependent on the prices of all goods:

$$D_i = D_i(p_1, p_2, \ldots, p_n) = D_i(P) \text{ where } P \text{ represents a set of } n \text{ prices.}$$

Walras wanted to prove that P^* exists for which $\quad D_i(P^*) = S_i, \; i = 1 \ldots n$

State this in terms of excess demand because ED (+ or -) drives price changes:

$$ED_i(P) = D_i(P) - S_i \text{ for all } i = 1, 2, \ldots, n$$

The question is whether a set of equilibrium P^* exists for which

$$ED_i(P^*) = 0 \text{ for all } i = 1,2,\ldots,n$$

These n ED functions are not independent of each other. They are related by

$$\sum_{i=1}^{n} p_i \cdot ED_i(P) = 0$$

<u>Walras' Law</u> (see Footnote 11, Page 350 for proof)

For a city park: If $p_i = 0$, $ED_i < 0$ (Ex. Sup.), If $p_i > 0$, $ED_i = 0$ (not free; price rations park use). For all other goods, pi>0 and Edi<0 or pi>0 and Edi>0.

Walras' Law says that the ith good's ED times its price summed over all goods is zero, ie., total value of excess demand is zero. When all goods are summed, there can be no positive or negative value of ED.

For <u>equilibrium</u>, Walras' Law is obvious because $ED_i = 0$ for all i, but this law is true for equilibrium and non-equilibrium prices (as in the graph two slides earlier).

The system of equations, $ED_i(P) = 0$, $i = 1,2,...,n$, for all i can be solved simultaneously because $n - 1$ of these are independent and can be solved for $n - 1$ equilibrium prices (big job; some equations are nonlinear). Walras solved this system of equations iteratively to approximate equilibrium prices and proved that equilibrium prices do exist.

Because these equations can be solved for only n-1 equations, relative prices are important, not absolute prices. Must introduce money to look at actual prices. Money doesn't change the price ratio at which goods trade. It just acts as: A medium of exchange, a store of value, and a unit of account.

Efficiency of Perfect Competition

The free working of all connections and resulting adjustments in the perfectly competitive economic world appear very chaotic. It may appear that no good end could come from so much apparent chaos. Surely, careful planning can bring about a better allocation of resources!

Adam Smith's "invisible hand" concept pointed out that self interest and freely competitive markets would lead to maximum welfare for society as a whole.

Smith's ideas lead to the notion that efficient allocation of resources would result from competitive pricing of those resources.

Pareto Efficiency

An allocation of resources is Pareto efficient if it is not possible (through further reallocation) to make one person better off without making someone else worse off.

Inefficiency is indicated if unambiguous improvement in welfare can be made.

A. Efficiency in Production or Technical Efficiency (no prices yet)

It occurs when an economy is on its PPF (not just each firm, but all firms together).

In Pareto terms, production efficiency (or technical efficiency) occurs when no more of one good can be produced without reducing production of another good. Thus, any point inside the economy's PPF is inefficient.

Technical efficiency is a necessary condition for overall economic efficiency.

Three conditions must hold to have technical efficiency:

1. Efficient allocation of inputs **within each firm** (1 firm, 2 inputs, 2 outputs).

    We have shown that an efficient allocation of inputs between outputs would occur where the RTSs are the same for all outputs. <u>Thus, a firm producing two outputs with two inputs would be efficient when the slopes of the isoquants are the same ($RTS_x = RTS_y$).</u>

    All points along the O_xO_y line in the Edgeworth box are efficient in production. On this line, a firm cannot produce more x without reducing y production.
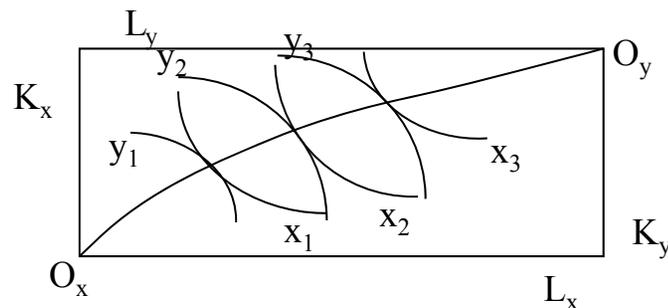
Doesn't say anything about how much x and y to produce or how much K and L to use to produce each output.

Efficient allocation of inputs **within each firm** Mathematically:

If the firm's production functions are $x = f(K_x, L_x)$ and $y = g(K_y, L_y)$ and full employment is assumed ($\overline{K}$ and $\overline{L}$) then $y = g(\overline{K} - K_x, \overline{L} - L_x)$.

Efficiency requires that x be as large as possible for any given y, say $\overline{y}$.

Could Maximize: $x = f(K_x, L_x)$ st : $\overline{y} = g(K_y, L_y)$

$$\ell = f(K_x, L_x) + \lambda(\overline{y} - g(\overline{K} - K_x, \overline{L} - L_x))$$

$$\frac{\partial g}{\partial L_x} = -\frac{\partial g}{\partial L_y} < 0$$

FOC: 1) $\dfrac{\partial \ell}{\partial K_x} = f_{K_x} + \lambda g_{K_x} = 0$, 2) $\dfrac{\partial \ell}{\partial L_x} = f_{L_x} + \lambda g_{L_x} = 0$

3) $\dfrac{\partial \ell}{\partial \lambda} = \overline{y} - g(\overline{K} - K_x, \overline{L} - L_x) = 0$ Ratios of MP are equal for all outputs.

Divide FOC 2 by 1 to get: $\dfrac{f_{L_x}}{f_{K_x}} = \dfrac{g_{L_y}}{g_{K_y}} = \dfrac{MP_L^x}{MP_K^x} = \dfrac{MP_L^y}{MP_K^y} = RTS_{LK}^x = RTS_{LK}^y$

<u>Allocation Rule 1:</u> <u>Efficient allocation of a fixed quantity of inputs within a firm occurs where all inputs are fully employed and the RTS between the inputs is the same for all outputs.</u>

Same as shown on $0_x 0_y$ in Edgeworth Box (production). The firm is on its PPF. Thus, the tangencies of the isoquants are where x is maximized given y.

2.   Efficient allocation of **inputs among firms** (2 firms, 2 inputs, 1 output).
Inputs should be allocated to the firms where they are used most efficiently.
Suppose two firms produce the same good x with production functions:

$$x_1 = f1(K_1, L_1), \ x_2 = f2(K_2, L_2) \ \text{ and total quantities of inputs are } \overline{K} \text{ and } \overline{L}.$$

$$\text{Max}: \ x = f1(K_1, L_1) + f2(K_2, L_2) \qquad St: K_2 = \overline{K} - K_1 \text{ and } L_2 = \overline{L} - L_1$$

Substitute the constraints into the objective function:

$$\text{Max } x = f1(K_1, L_1) + f2(\underset{K_2}{\overline{K} - K_1,} \ \underset{L_2}{\overline{L} - L_1})$$
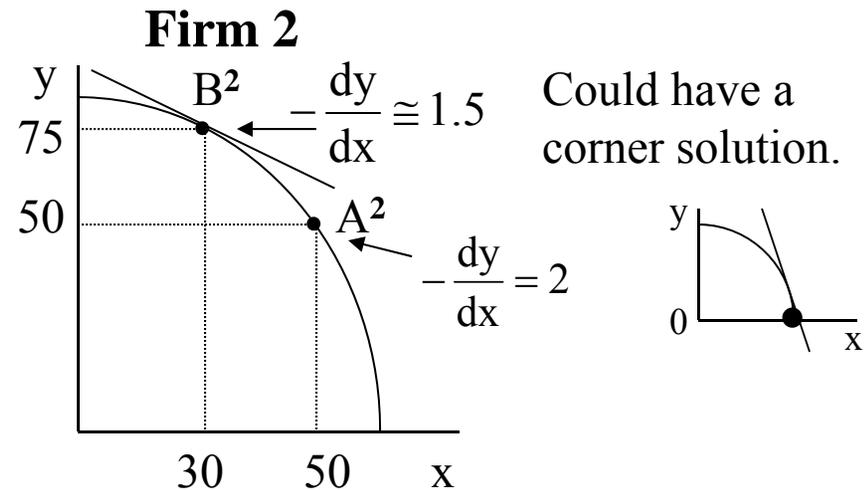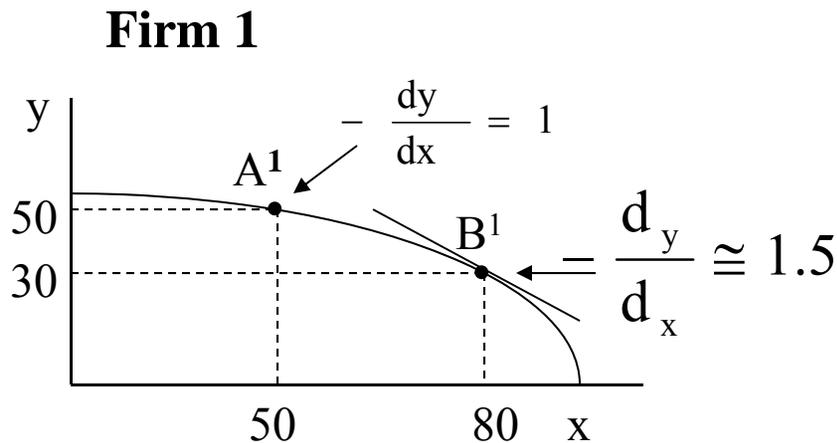
Changes in K_1 must have the same effect as changes in K_2 except opposite in sign, because $K_1 + K_2 = \overline{K}$.

FOC:
$$\frac{\partial X}{\partial K_1} = \frac{\partial f1}{\partial K_1} + \frac{\partial f2}{\partial K_1} = \frac{\partial f1}{\partial K_1} - \frac{\partial f2}{\partial K_2} = 0 \Rightarrow \frac{\partial f1}{\partial K_1} = \frac{\partial f2}{\partial K_2} = \ MP_K^1 = MP_K^2$$

$$\frac{\partial X}{\partial L_1} = \frac{\partial f1}{\partial L_1} + \frac{\partial f2}{\partial L_1} = \frac{\partial f1}{\partial L_1} - \frac{\partial f2}{\partial L_2} = 0 \Rightarrow \frac{\partial f1}{\partial L_1} = \frac{\partial f2}{\partial L_2} = \ MP_L^1 = MP_L^2$$

Allocation Rule 2: For efficient production, inputs should be allocated among firms such that the MP of each input in the production of a given good is the same no matter which firm produces that good. In production of a single good, MP's of each input are the same among firms.

3. Efficient **choice of outputs by firms** (2 firms, constant inputs, 2 outputs). This refers to both what and how much each firm should produce (same question) $\Rightarrow$ "specialization". The RPT for two goods, each produced by two firms, must be equal between the two firms ($RPT^1_{xy} = RPT^2_{xy}$).

Firm 1

Firm 2

$-\dfrac{dy}{dx} = 1$

A^1

B^1

$-\dfrac{d_y}{d_x} \cong 1.5$

B^2 $-\dfrac{dy}{dx} \cong 1.5$ Could have a corner solution.

A^2

$-\dfrac{dy}{dx} = 2$

If two firms produce equal amounts of two goods and if the RPT for Firm 1 is $-dy/dx = 1$ at A^1, while for Firm 2 it is 2 at A^2, then the first firm should produce more x and the second firm should produce more y until RPT's are equal (somewhere between 1 and 2; possibly at 1.5 in graph). At points B (B^1 and B^2), $RPT^1_{xy} = RPT^2_{xy}$. Firms should do what they are good at doing. If both firms are producing 50x and 50y at A^1 and A^2 (total is 100 of each good), Firm 1 could move to B^1 and Firm 2 to B^2, resulting in totals of 110x and 105y.

•This rule also means that $\dfrac{MC_x^1}{MC_y^1} = \dfrac{MC_x^2}{MC_y^2}$.

•The MC's for x and y are not necessarily equal between firms; just the ratios are equal between firms.

•Either firm can have lower MC's for both goods and society still gain from firms specializing in production.

•This notion is used as the concept of **Comparative Advantage** in international trade.

•**Allocation Rule 3:** Two firms producing the same goods must operate where their RPT's are equal on their PPF's.

 These three allocation rules mean the economy is somewhere on its PPF (ie., technical efficiency). Consumers have the opportunity to get the most out of the economy's resources.

Efficiency in Product Mix Mathematically

Assume two goods, x and y, and that preferences are determined by society's preferences:

U = U(x,y) is society's utility function,

T(x,y) = 0 is the implicit production possibilities frontier for all firms.

The problem is to maximize U subject to T. The Lagrangian is:

$$\ell = U(x,y) + \lambda(-T(x,y))$$

The right-hand side of this expression is $\frac{\partial T}{\partial x} \cdot \frac{\partial y}{\partial T} = \frac{\partial y}{\partial x}$, which is the amount of y given up for a small increase in x (ie., the opportunity cost of x in terms of y).

FOC

$$\partial\ell/\partial x = \partial U/\partial x - \lambda\,\partial T/\partial x = 0$$
$$\partial\ell/\partial y = \partial U/\partial y - \lambda\,\partial T/\partial y = 0$$
$$\partial\ell/\lambda = -T(x,y) = 0$$

Divide 1st FOC by 2nd FOC to get

$$\frac{\partial U/\partial x}{\partial U/\partial y} = \frac{\partial T/\partial x}{\partial T/\partial y}$$

Negative slope of the indifference curve (U fixed)

$$-\frac{dy^{Ind}}{dx} = MRS_{xy} = \frac{MU_x}{MU_y} = \frac{MC_x}{MC_y} = RPT_{xy} = -\frac{dy^{PPF}}{dx}$$

Negative slope of PPF (resources fixed)

$$-\frac{dy^{Ind}}{dx} = MRS_{xy} = \frac{MU_x}{MU_y} = \frac{MC_x}{MC_y} = RPT_{xy} = -\frac{dy^{PPF}}{dx}$$
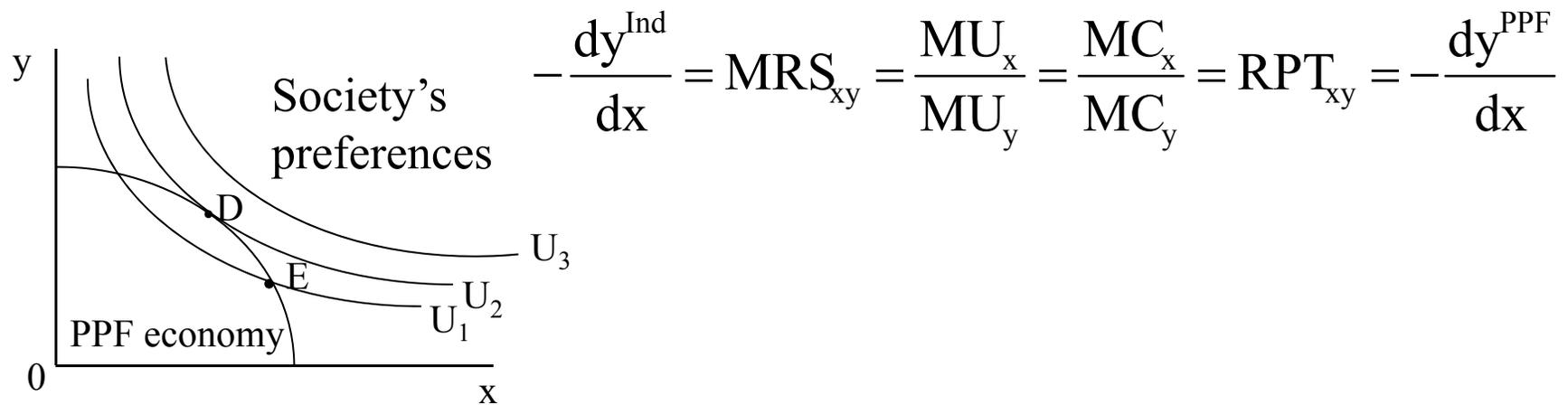
These conditions will give *Pareto Efficiency* at point D because at points other than D, the consumer or producer can be made better off without making others worse off.

Because this is the GE solution produced earlier by free markets and price movements, this shows that the free market GE result is *Pareto Efficient* under conditions of perfect competition.

We did not need prices to show *Pareto Efficiency.* We will see, however, that perfectly competitive pricing brings about Pareto Efficiency by causing society to reach point D.

Summary of Pareto Efficiency for the Economy

A. **Criteria for production (technical) efficiency (no prices yet).**

- **Efficient choice of inputs within each firm.**

- (Rule 1) 1 firm, 2 inputs, 2 outputs

$$RTS_{LK}^{x} = RTS_{LK}^{y} \Rightarrow \frac{MP_L^x}{MP_K^x} = \frac{MP_L^y}{MP_K^y}$$

- **Efficient allocation of inputs among firms.**

- (Rule 2) 2 firms, 2 inputs, 1 output

$$MP_K^1 = MP_K^2 \text{ and } MP_L^1 = MP_L^2$$

- **Efficient choice of outputs by firms.**

(Rule 3) 2 firms, fixed inputs, 2 outputs

$$RPT_{xy}^1 = RPT_{xy}^2 \Rightarrow \frac{MC_x^1}{MC_y^1} = \frac{MC_x^2}{MC_y^2}$$

B. **Criteria for efficiency in product mix (no prices yet).**

- Production (technical) efficiency (Rules 1-3), and

- $$-\frac{dy^{Ind}}{dx} = MRS_{xy} = \frac{MU_x}{MU_y} = \frac{MC_x}{MC_y} = RPT_{xy} = -\frac{dy^{PPF}}{dx}$$
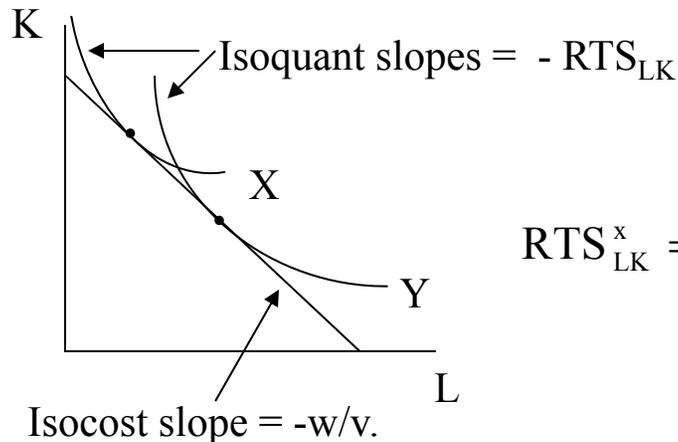
C. <u>Competitive Prices and Efficiency</u> (now add prices) – The First Theorem of Welfare Economics

If all economic agents (producers and consumers) are considered together, a Pareto efficient allocation of resources simply means that the rate of trade-off between any two goods or inputs is the same for all agents. This rate of trade-off will equal the ratio of the two goods' or inputs' prices in a perfectly competitive situation. All agents are price takers and they all face the same prices. Thus, all trade-off rates will be equalized. This is the First Theorem of Welfare Economics.

A. Technical (or Production) Efficiency

1. Allocation Rule 1 said that the RTS between any two inputs used by a single firm must be the same for all goods produced by the firm. But if markets for inputs are perfectly competitive, the RTS_{LK} for each output will equal a common ratio of input prices (w/v), causing the firm's RTSs of L for K to be equal for all outputs. Thus, the RTSs of L for K will be the same across all outputs if the firm maximizes profit under perfect competition.

1 firm, 2 goods,
2 inputs

Isoquant slopes = - RTS_{LK}

For profit maximization,

$$RTS^{x}_{LK} = \frac{MP^{x}_{L}}{MP^{x}_{K}} = -\frac{dK^{x}}{dL^{x}} = \frac{w}{v} = -\frac{dK^{y}}{dL^{y}} = \frac{MP^{y}_{L}}{MP^{y}_{K}} = RTS^{y}_{LK}$$

Isocost slope = -w/v.

2. <u>Allocation Rule 2</u> said that all firms that use a given input to produce a given output will have the same MP for that input in producing that output. This condition will hold because in perfect competition all firms will face the same input and output prices. Thus, when each profit-maximizing firm equates its output P (= MR) times the MP of the input (MRP) to the MIC of the input (= w or v), each firm's MP of the input must equal the MP for all other firms. This will be true for each input that the firm uses to produce the given output because w (or v) and P are common to all firms.

$$\overset{MR_x}{\underset{\downarrow}{}} \qquad \overset{MIC_L}{\underset{\downarrow}{}} \qquad \overset{MR_x}{\underset{\downarrow}{}} \qquad \overset{MIC_K}{\underset{\downarrow}{}}$$

$$p(MP_L^x) = w \text{ and } p(MP_K^x) = v$$

All firms face w/p, so the MPs of labor will be equal across all profit maximizing firms producing x. Same for v/P.

$$MP_L^x = \frac{w}{p} \text{ and } MP_K^x = \frac{v}{p}$$

$$MP_L^{xFirm1} = \frac{w}{p} = MP_L^{xFirm2} \text{ and } MP_K^{xFirm1} = \frac{v}{p} = MP_K^{xFirm2}$$

3. <u>Allocation Rule 3</u> said that the RPT for any two goods will be the same for all firms producing the two goods (given input levels). This condition holds in perfect competition because the RPT = MC_x/MC_y and each firm will produce where $MC_x = p_x$ and $MC_y = p_y$. Thus, because p_x and p_y are common to all firms, so are MC_x and MC_y, and so are MC_x/MC_y, and so are RPT_{xy} for all firms.

**Firms 1 & 2**   **Firm 1**   **Firm 2**
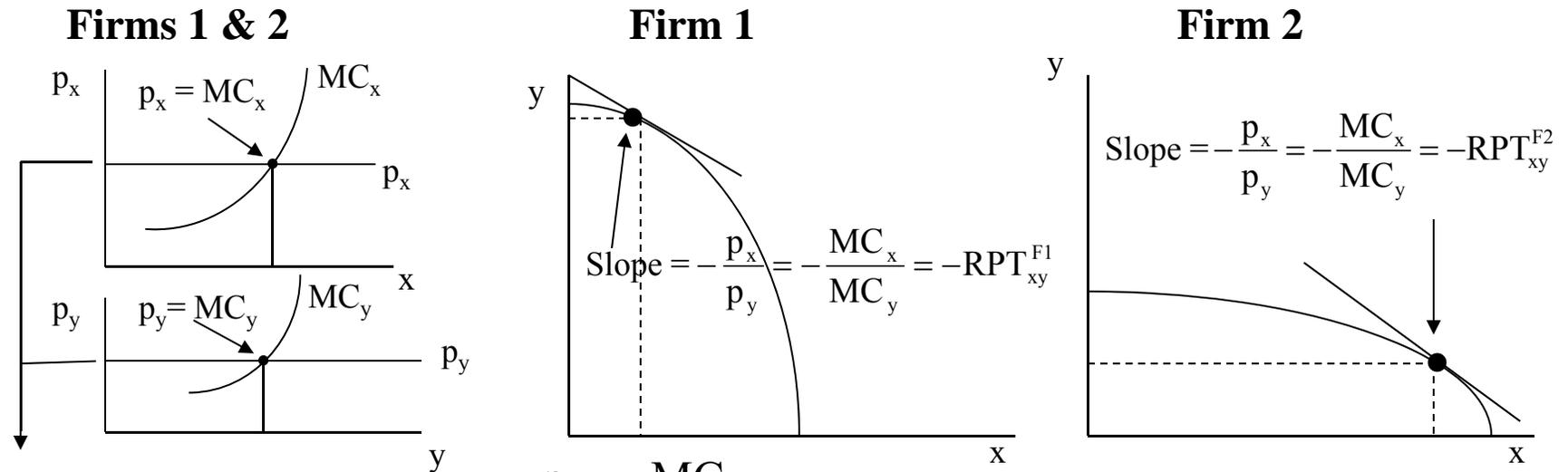
All firms face p_x and p_y, so $\dfrac{p_x}{p_y} = \dfrac{MC_x}{MC_y} = RPT_{xy}$ for all firms.

Thus, self interest (profit-maximizing behavior) combined with perfectly competitive markets will lead to efficiency in production, meaning the economy is somewhere on its PPF. Prices act as signals to profit-maximizing decision-makers to bring about efficiency in production for the economy.

B. Efficiency in Product Mix

Because output prices to producers are costs of goods to consumers (and these are the same for all producers and consumers), the MRS common to all consumers will equal the RPT common to all producers for any two goods. Again, equilibrium prices assure that $Q_D = Q_S$ for all goods individually. Efficiency is assured because all consumers and producers face the same prices! $MRS_{xy} = P_x/P_y = RPT_{xy}$.
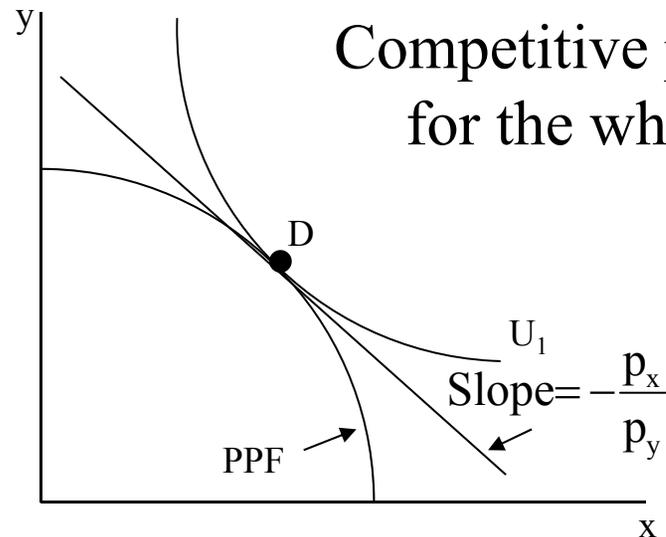
Competitive pricing brings about the GE solution for the whole economy RPT = MRS!

We previously demonstrated that point D is a stable equilibrium. Tendency toward equilibrium is assured by prices, excess demand, and excess supply.

y

D

U_1

$Slope = -\dfrac{p_x}{p_y}$

PPF

x

The GE is the result of Adam Smith's "Invisible Hand."

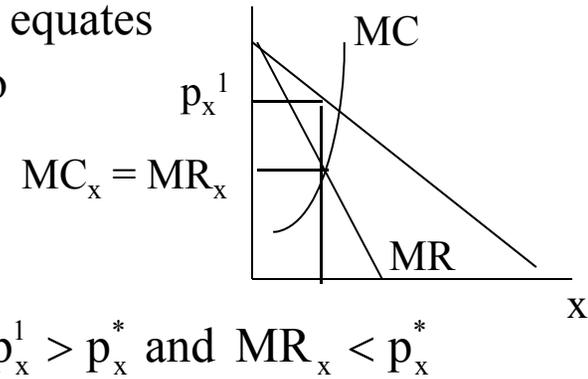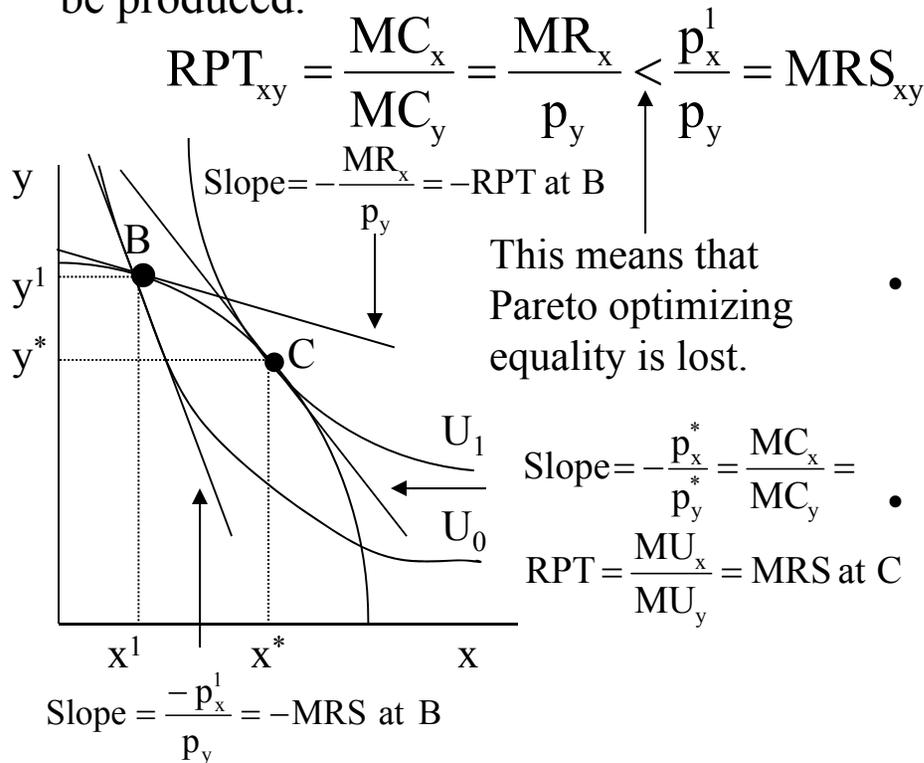# Conclusions about Competitive Pricing and Efficiency

- Given the assumptions of perfect competition, it is not the public spirit or kind-heartedness of producers nor the directions of governments that lead to efficiency. Rather, it is self interest and competition that lead to efficiency through price signals that carry information about consumer preferences and producer technologies, given available resources.

- Because perfect competition leads to perfect efficiency, and intervention is likely to be counter efficient (sends wrong price signals). Self-interest (U-Max and π-Max) and competition make the world a better place to live!"

- If only the markets of our world were perfectly competitive! In general, they are not.

Effects of Departures from Competition

Three types of departures from competition exist: 1) Imperfect competition, 2) Externalities, and 3) Public goods.

Imperfect Competition occurs when agents have power to

noticeably affect price. Thus, the producer realizes that as his/her output increases, market price declines causing $MR_x < p_x$. The producer equates MC_x to $MR_x (< p_x)$, which causes less than optimal X to be produced.

$$RPT_{xy} = \frac{MC_x}{MC_y} = \frac{MR_x}{p_y} < \frac{p_x^1}{p_y} = MRS_{xy}$$

$Slope = -\frac{MR_x}{p_y} = -RPT \text{ at B}$

This means that Pareto optimizing equality is lost.

y

B

y^1

y^* C

U_1

$Slope = -\frac{p_x^*}{p_y^*} = \frac{MC_x}{MC_y} =$

U_0

$RPT = \frac{MU_x}{MU_y} = MRS \text{ at C}$

x^1 x^* x

$Slope = \frac{-p_x^1}{p_y} = -MRS \text{ at B}$

•Anytime we have a divergence between MR and p the price system will not lead to Pareto efficiency because the communication mechanism is faulty!

MC

p_x^1

$MC_x = MR_x$

MR

x

$p_x^1 > p_x^* \text{ and } MR_x < p_x^*$

- If y has a perfectly competitive market but x does not, too much y and too little x will be produced compared with the competitive equilibrium at point C.

- Rather, equilibrium B will occur and utility will be only U_0 rather than the U_1 that could have been attained with the available resources and technology (PPF).

- The economy is still on its PPF, so production is efficient, but the product mix is not efficient.

- Market prices did not lead to Pareto efficiency for the economy.

Externalities

- Externalities occur when not all costs or benefits of an activity are reflected in the market price. Pollution by a manufacturer is a common example. Pollution is an effect not accounted for in the price system.

- Externalities occur when the benefits or costs to society diverge from the private benefits and costs of decision-makers (economic agents). A cost to society is left out of the firm's MC curve, so MC does not reflect the total cost of resources used to produce the last unit of output.

- Or a benefit to society is left out of the good's market price. MR or P does not reflect total satisfaction to society of the last unit consumed.

- Society's RPT ≠ the firm's RPT and/or society's MRS ≠ the consumer's MRS.

Public Goods

- Goods for which the production or purchase by one agent makes the good (or benefits from it) available to others on a nonexclusive basis. Thus, each potential producer or consumer waits for someone else to pay for the good so they can benefit without paying (free-rider problem).
- Examples are pest control, national defense, light houses, and education. These goods will be under-produced by the free market and are usually provided by government.

Distributional Problems

- Distribution of the benefits of efficient production and product mix may be regarded as unfair.

- Nothing in our model assures fairness.

- Definitions of fairness vary, but an economy can have Pareto efficiency where a few individuals are wealthy and wasteful, while others freeze and starve.

- Attempts to improve distribution have met with mixed success and have had many undesirable side-effects (eg., food aid to less developed countries).
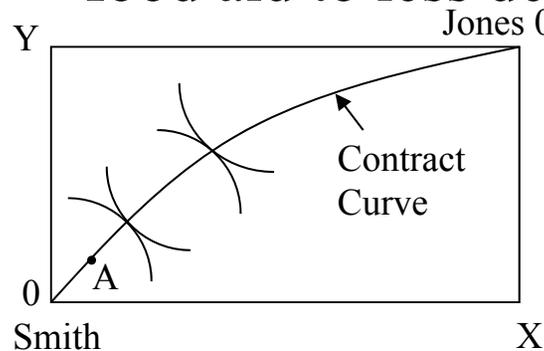
At point A on the Contract Curve, Smith is poor and Jones is rich, but $MRS_{XY\ Smith} = MRS_{XY\ Jones}$. If the economy is on its PPF at point A, Pareto efficiency exists in the economy.

Exchange with Initial Endowments
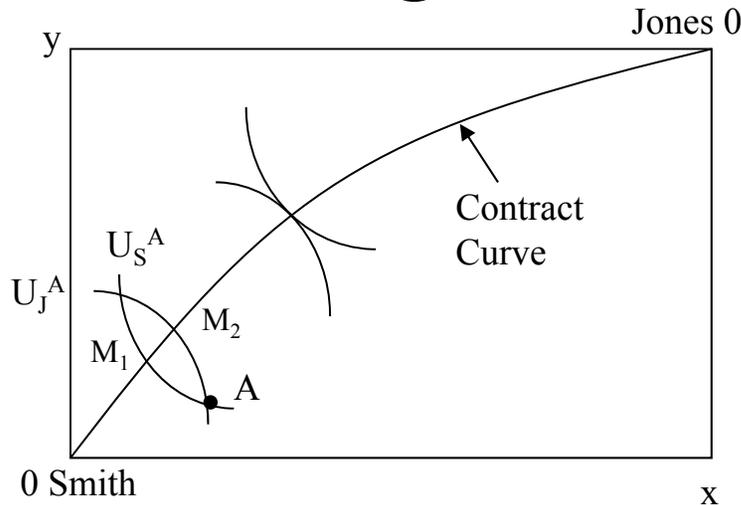
In this case, initial endowments are represented by point A. Initial endowments favor Jones (Jones on higher indifference curve than Smith). Smith and Jones can both move to higher indifference curves if they trade goods x and y until they reach the contract curve between M1 and M2.

Even though Jones is rich he/she will not trade to reduce his/her utility by reaching the contract curve to the right of M_2 and Smith will not trade to reduce utility by reaching the contract curve to the left of M_1. Therefore, because of differences in initial endowments, Smith will remain poor and Jones will remain rich even after they trade in response to competitive prices (assumes Jones receives no utility from giving to Smith).

The Second Theorem of Welfare Economics states that any desired distribution of welfare among the individuals in an economy can be achieved in an efficient manner through competitive pricing if initial endowments are adjusted appropriately. Economists frequently argue for competitive pricing to make the economic pie as large as possible, and then adjust the resulting distribution to be "fair" though the use of lump-sum transfers.