Analyzing Economic Efficiency

We will consider three aspects of efficiency which are required for Pareto efficiency.

1. Exchange Efficiency: The economy must achieve exchange efficiency. That means whatever goods are produced have to go to the individuals who value them most.

   EX: If I like shrimp and you like pork, I should get shrimp fried rice and you should get pork fried rice.

2. Production Efficiency: The society has limited resources so the production of one good cannot be increased without decreasing the production of another. That's why the production must be efficient.

3. Product Mix Efficiency: The economy must achieve product mix efficiency so that the goods produced correspond to those desired by individuals.

   Ex: If individuals value chocolate a lot relative to cake, and if the cost of producing chocolate is low relative to cake, then more chocolate should be produced.

In order to analyze the economic efficiency, we need to know about the following topics in details.

The Utility Possibilities Curve

The concept of the utility possibilities curve is useful for studying the three aspects of Pareto efficiency. The utility is the benefit that an individual gets from his consumption. If he gets more goods, his utility is increased.

The utility possibilities curve shows the combination of the maximum level of utility that may be achieved by two consumers.

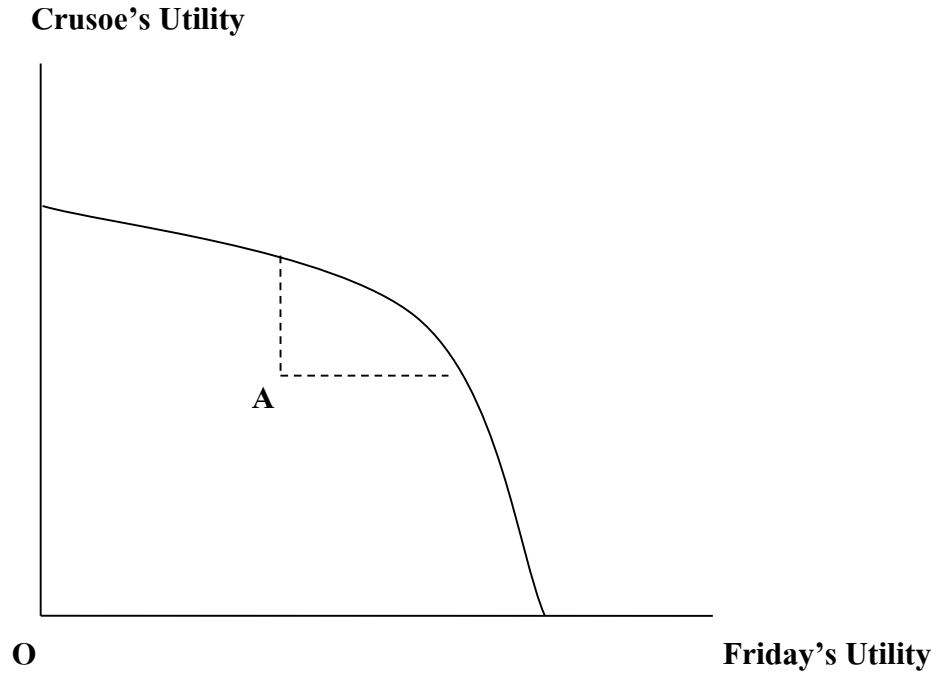
The classic example of the utility possibilities frontier is the utility possibilities frontier of Robinson Crusoe and Friday. This frontier shows Friday's maximum level of utility, given Crusoe's level of utility (and vice versa).

An economy is Pareto efficient if no one can be made better off without making someone else worse off. That is, we cannot increase Friday's utility without decreasing the utility of Crusoe. So if an economy is Pareto efficiency, it must be operating along the utility possibilities frontier.

If the economy is operating at a point below the utility possibilities frontier, such as Pt. A in Figure 1, it would be possible to increase the utility of Friday or Crusoe without decreasing the utility of the other, or to increase the utility of both.

Figure 1

The utility Possibilities Curve



The first fundamental theorem of welfare economics says that a competitive economy operates along the utility possibilities frontier.

The second fundamental theorem of welfare economics says that we can attain any point along the utility possibilities frontier using competitive markets if we redistribute initial endowments appropriately.

Exchange Efficiency

To achieve exchange efficiency, we are concern with the distribution of goods. If the exchange is efficient, the goods in the economy are distributed in the way that no one can be made better off without someone else being made worse off. So once we have achieved exchange efficiency, there are no longer any exchanges that can make both parties better off.

From our example of Robinson and Friday:

Assume that Robinson is willing to give up one apple in exchange for one orange, or to get one apple in exchange for giving up one orange. (Robinson: 1 apple = 1 orange).

Assume that Friday is willing to give up 3 apples if he can get one more orange. (Friday: 3 apples = 1 orange).

Friday values oranges more highly than does Robinson.

There is room for a deal. If Robinson gives Friday one of his oranges and Friday gives Robinson 2 of his apples. Both are better off.

Robinson requires only one apple to make him just as well off, but he gets 2 in exchange for his orange. So he is better off.

Friday is willing to give up 3 apples but he only gives up 2, so he is better off.

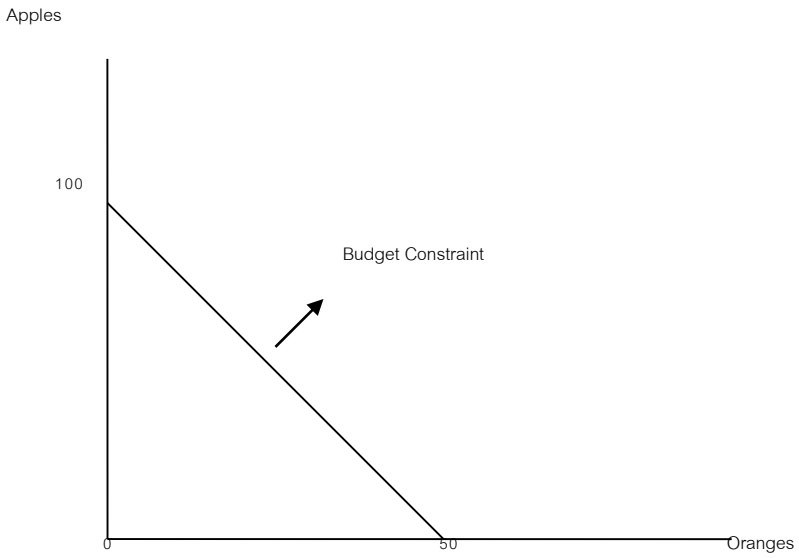
The amount of one commodity which an individual is willing to give up in exchange for a unit of another commodity is called the *marginal rate of substitution*. As long as the marginal rates of substitution of Robinson and Friday differ, there will be room for a deal. Thus, ***exchange efficiency requires that all individuals have the same marginal rate of substitution.***

We will now show why competitive economies satisfy the condition of exchange efficiency. We will start with how consumers make their decisions. Consumers have their budget constraint which is the amount of income a consumer can spend on various goods.

EX: Assume that Robinson has 100 bahts. If an apple costs 1 baht and an orange 2 bahts. He can buy 100 apples or 50 oranges or some combination in between (Figure 2). If he buys one more orange, he has to give up 2 apples. The slope of the budget constraint is equal to the ratio of the prices.

Figure 2

Robinson's budget constraint



Robinson will choose the point along the budget constraint that he most prefers.

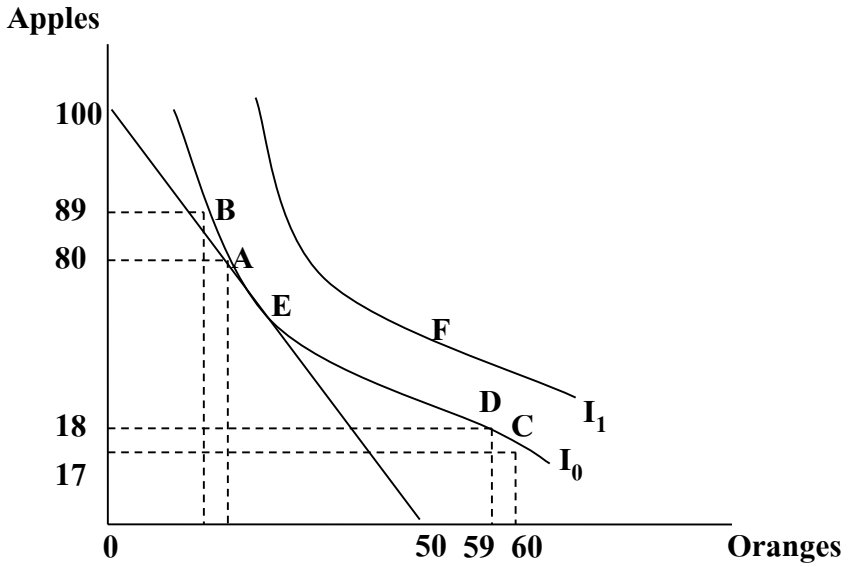
Another concept that we learn from Microeconomics is the *Indifference Curve* which give the combinations of goods among which an individual is indifferent or which yield the same level of utility.

Figure 3 shows the indifference curves for apples and oranges. If pt. A and pt. B are on the same indifference curve, the consumer is indifferent between the 2 combinations of apples and oranges.

The indifference curve also shows how much of one good (apples) the consumer is willing to give up in return for one more unit of another good (oranges).

Figure 3

The Consumer's Choice Problem



The amount of one good the individual is willing to give up in return for one more unit of another good is the *marginal rate of substitution*. So the slope of the indifference curve equals the marginal rate of substitution.

From Figure 4, in moving from pt. A to pt. B, Robinson gives up 1 orange, but he will be just as well off if he is compensated with 9 extra apples (80 to 89). Notice that the number of apples that he needs to compensate him for having one less orange is much higher when he moves from A to B than when he moves from C to D. When he has 60 oranges, he is much

more willing to give up one of his oranges (60 to 59). He only needs one more apple to compensate him (17 to 18). Thus, the marginal rate of substitution diminishes as the number of oranges which Robinson consumes increases. That's why the indifference curves are downward-sloping.

The combination of goods along a higher indifference curve give a higher level of utility because the individuals are better off if they have more goods (apples and oranges). The points on I_1 are more attractive than the points on I_0. Consumers want to be along the highest indifference curve possible. Robinson will want to be on the indifference curve I_1 but he cannot. All points on I_1 lie above his budget constraint and they are not feasible. The best that he can do is to choose Pt. A where his indifference curve is tangent to his budget line.

At the point of tangency, the slope of the indifference curve is identical to the slope of the budget constraint.

The slope of the indifference curve is the marginal rate of substitution.

The slope of the budget line is the price ratio.

Thus, the individuals choose a combination of apples and oranges is where the marginal rate of substitution is equal to the price ratio.

In a competitive economy, all consumers face the same prices and they set their marginal rates of substitution equal to the price ratio. So they all have the same marginal rate of substitution.

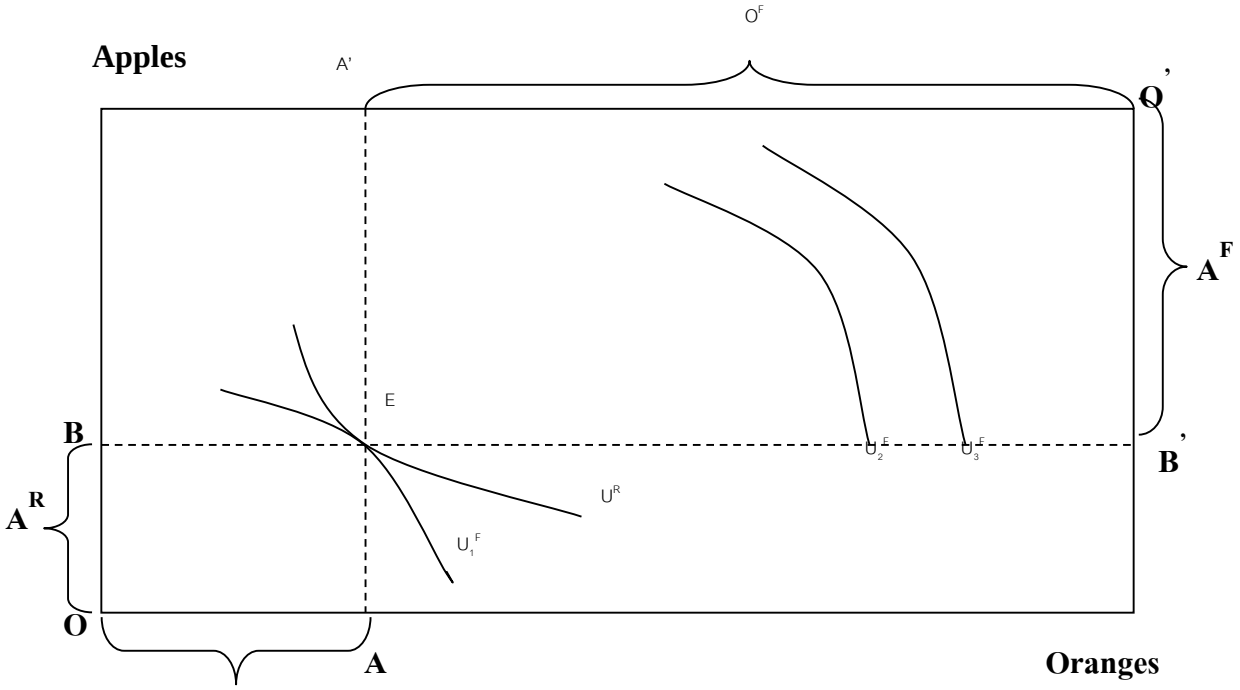
The *condition for exchange efficiency* is that *all individuals have the same marginal rate of substitution* so the competitive markets have exchange efficiency.

We can use an Edgeworth-bowley Box as another way to represent the exchange efficiency. Expanding our example of Robinson and Friday, whatever Robinson doesn't get, Friday gets. We represent all possible allocations in a box (Figure 4) where the horizontal axis represents the total supply of oranges and the vertical axis represents the total supply of apples.

What Robinson gets to consume is measured from the bottom left corner (O), and what Friday gets is measured from the top right corner (O'). At pt. E, Robinson gets OA oranges and OB apples, while Friday gets the remainder (O'A' oranges and O'B' apples). Then we draw Robinson's and Friday's indifference curves.

Figure 4

Edgeworth-Bowley Box



Robinson's Consumption of oranges

If we fix Robinson's utility. Pareto efficiency requires us to maximize Friday's utility, given the level of utility attained by Robinson. If Robinson is on the indifference curve, U^R, what is the highest indifference curve that Friday can get to? Friday's utility will increase as we move down and to the left (Friday is getting more goods, Robinson fewer goods). Friday attains his highest utility where his indifference curve is tangent to

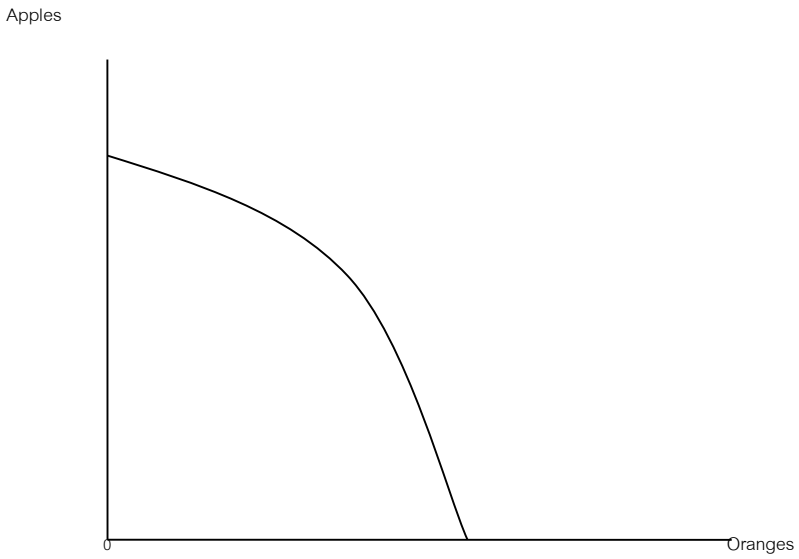
Robinson's, at pt. E. At this point, the slopes of the indifference curves of both Robinson and Friday are the same, that is, their marginal rates of substitution of apples for oranges are the same.

Product Efficiency

Given a fixed amount of resources, along the production possibilities frontier in Figure 5, the economy cannot produce more of one good without giving up some of another good.

Figure 5

The Production Possibilities Frontier



On the production side, consider Figure 6. Instead of the budget line we have an isocost line which giving the different combinations of inputs that cost the firm the same amount. The slope of the isocost line is the relative price of the two factors.

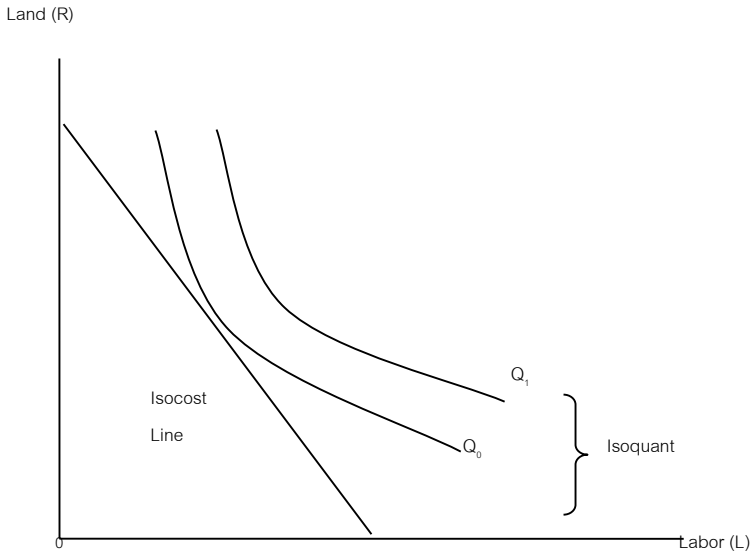
In Figure 6, we have two isoquants. The isoquant shows the different combination of inputs that produce the same quantities of outputs. The inputs in this case are land and labor. The isoquant and the indifference curves are equivalent.

The slope of the isoquant is the *marginal rate of technical substitution.*

The marginal rate of substitution is the amount of one input (land) required to compensate for a decrease in the input of another input (labor) by one unit. When relatively little labor is being used, it is hard to economize further in its use, so if one less worker is used, there must be a large increase in land if output is to remain unchanged. That is why the isoquant is concave to the origin. There is a diminishing marginal rate of technical substitution.

Figure 6

Isoquants and Isocost Lines



Production efficiency requires that the marginal rate of technical substitution be the same for all firms.

In Figure 6, assume that the marginal rate of substitution between land and labor is 2 (2:1) in producing apples and 1 (1:1) in producing oranges. That means if we reduce labor by one in oranges, we need one more unit of land. If we reduce labor by one in apples, we need 2 more units of land. Conversely, if we increase labor by one in apples, we need 2 fewer units of land. If we take one worker from producing oranges and put him to work in apples, we take one unit of land, and switch it from producing apples to producing oranges, production of oranges is unchanged but production of apples is increased.

As long as the marginal rates of substitution differ, we can switch resources around, to increase production.

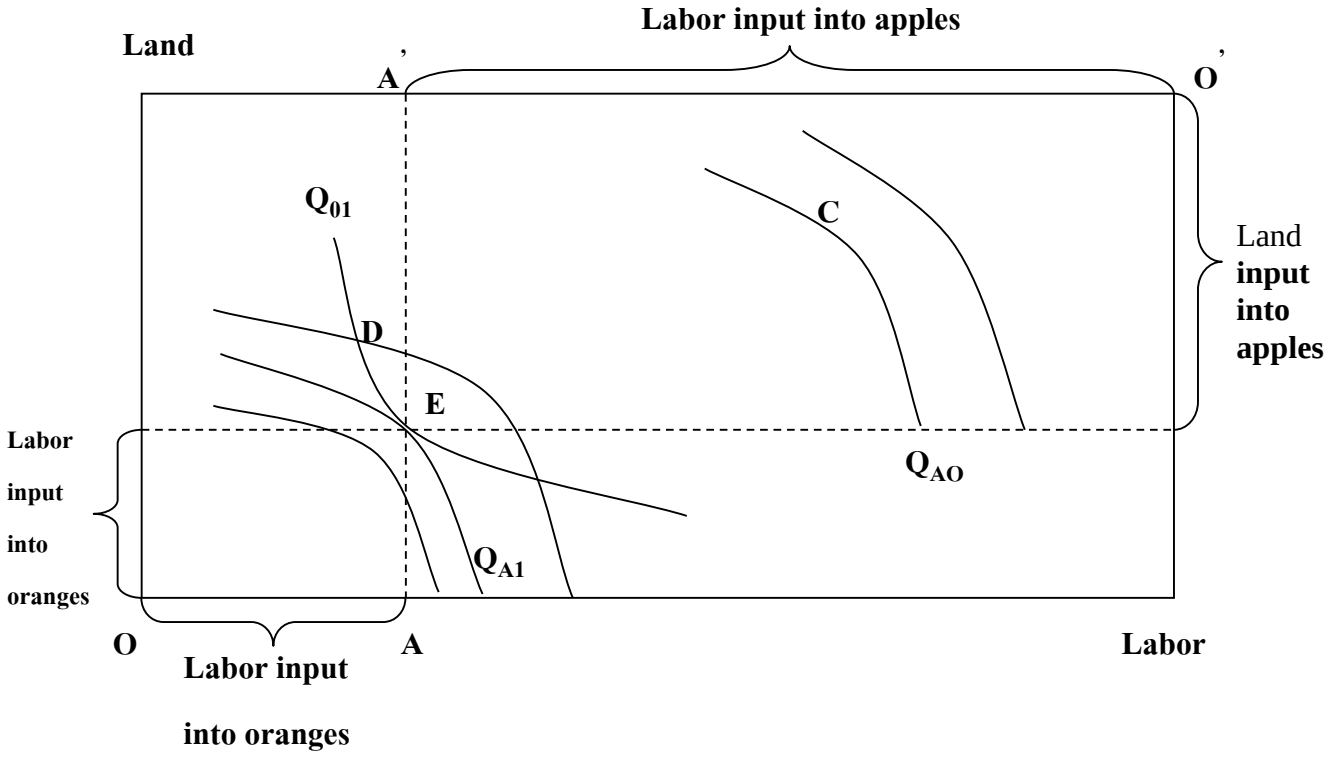
The firm maximizes the amount of output that it produces, at a given level of expenditures on inputs, by finding the point where the isoquant is tangent to the isocost line. At the tangency point, the slope of the 2 curves are the same. That means the marginal rate of technical substitution is equal to the ratio of the prices of the two inputs.

In a competitive market, all firms face the same prices, so all firms will set their marginal rate of technical substitution equal to the same price ratio. They all will have the same marginal rate of technical substitution which is the condition for product efficiency.

We can also use the Edgeworth box diagram to show the product efficiency condition in the market. We would like to allocate a fixed supply of inputs to ensure productive efficiency. We represent a fixed supply of inputs by a box (Figure 7). The total available supply of land is measured along the vertical axis and the total supply of labor is measured along the horizontal axis. We measure inputs into orange production from the bottom left-hand corner. Pt. E means that the amount OA of labor and the amount of OB of land is used in orange production. In turn it means that the rest of the inputs are used to produce apples. We measure inputs into apples from the upper right-hand corner. At pt. E, the amount O'A' of labor and the amount O'B' of land is used in producing apples.

Figure 7

Edgeworth Box Diagram for Production Efficiency



Q_o is the orange isoquant. Production efficiency requires that for any level of production of oranges the output of apples is maximized. If we move down and to the left of the box, more resources are being allocated to apple production (more output). If we fix the output of oranges at the level corresponding to isoquant Q_{o1}, the output of apples is maximized by finding the apple isoquant that is tangent to isoquant Q_{o1}.

If we produce Q_{o1} of oranges and produce Q_{a0} of apples (pt. C) means that some resources are unused.

If we produce along Q_{o1}, but not at pt. E (say at pt. D), it means that all resources are used but not efficiently. We can produce the same number of oranges and more apples at E. At pt. E, all resources are used efficiently and Q_{o1} of oranges are produced.

At the point of tangency, the slope of the isoquants are the same, that is the marginal rate of technical substitution of land for labor in the production of apples is the same as the marginal rate of technical substitution of land for labor in the production of oranges.

$$MRTS^{A}_{LL} = MRTS^{O}_{LL}$$

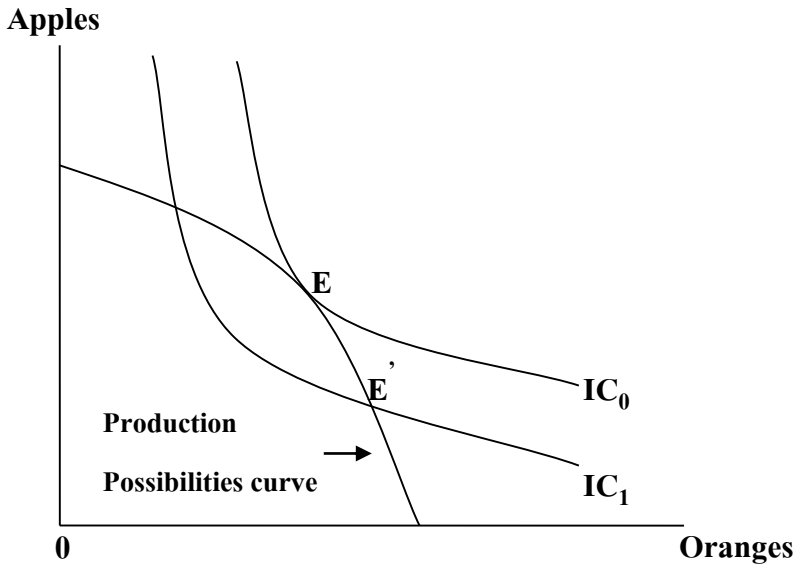
Product Mix Efficiency

To choose the best mix of apples and oranges to produce, we need to consider both what is technically feasible and individual's preferences. For each level of output of apples, we can determine from the technology the maximum feasible level of output of oranges. This is the production possibilities schedule. Given the production possibilities frontier, we want to get to the highest possible level of utility. We assume that all individuals have identical tastes. In Figure 8, we have both the production possibilities schedule and the indifference curves between oranges and apples. Utility is maximized at the point of tangency of the indifference curve to the production possibilities schedule.

The slope of the production possibilities schedule is the *marginal rate of transformation*. This rate tells us how many extra apples we can have if we reduce production of oranges by one. At the tangency point (E), the slopes of the indifference curve and the production possibilities schedule are the same, that is the marginal rate of substitution of apples for oranges is equal to the marginal rate of transformation.

Figure 8

Product Mix Efficiency



In a competitive market, the marginal rate of transformation will be equal to the relative price of apples to oranges. If we reduce production of apples by one and firms can increase the production of oranges by, say one, and sell the oranges for more than the price of apples, profit-maximizing firms will expand the production of oranges.

Under competition, consumer's marginal rates of substitution will equal the price ratio. Since both the marginal rates of substitution and the marginal rate of transformation will equal the price ratio, the marginal rate of transformation must equal consumers' marginal rates of substitution.

$$MRT_{xy} = MRS_{XY}$$

Thus, under ideal competitive markets, all three conditions required for Pareto efficiency are satisfied.