Introduction to Environmental Economics

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Lecture - 38
Market Efficiency and Optimality-II

Dear students, in the preceding lecture; I introduced the concept of Efficiency and Optimality and also explained the three types of efficiencies; technical efficiency, allocative efficiency and economic efficiencies. I also introduced two types of efficiencies; one in consumption or exchange and other in production.

In this lecture, you will study about efficiency in consumption or exchange. I will explain you first taking two convictional products, how efficiency and pareto optimality is achieved using two conventional products, which we generally consume and later on, I will introduce the same things in case of bad products that is actually environmental bad products like garbage and then, finally, I will sum up the topic.

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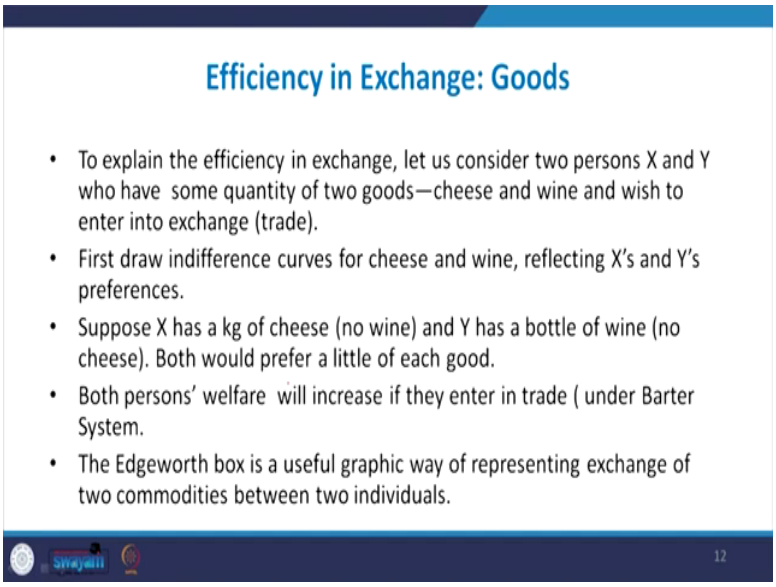

Let me now explain efficiency in exchange. First, I will take two good products and after that we will introduce the same concept by taking one good product and one bad product. To explain the inefficiency in exchange let us consider two persons say X and Y who have some quantity of two goods say cheese and wine and wish to enter into exchange, they wanted to trade.

First draw we can draw in difference curves for these two products for both the consumer X and Y and we can assume that X is having 1 kg of cheese, but no wine and Y is having a bottle of wine, but no cheese and both would prefer some quantity of both in order to maximize their utility or satisfaction and their welfare will increase, if they enter in the trade. We can enter in a barter system and if prices of the product are known, then price system can

also be introduced. So, in this case Edgeworth box is a useful graphic way of representing the exchange of two commodities between the two individuals.

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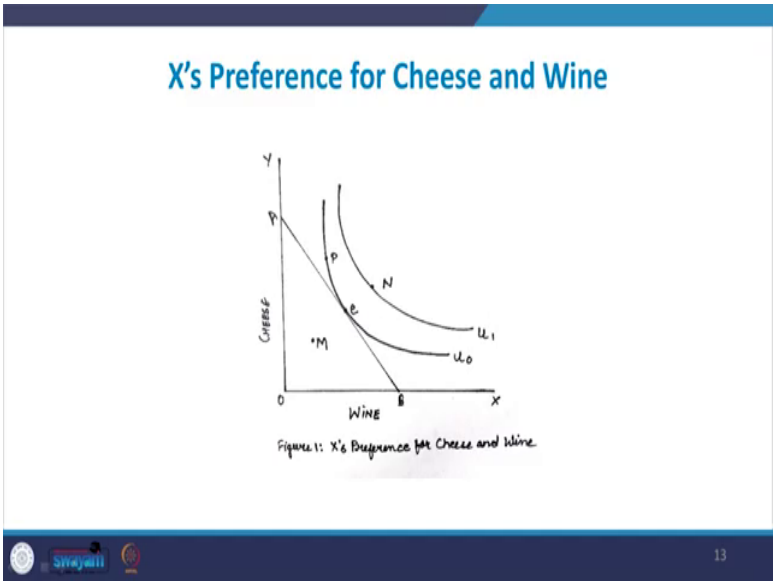

But before discussing the Edgeworth box, let me first take the X's preference for two product cheese and wine and here we take indifference curve u 0 and u 1 for X person. Similarly, you can also draw u 0, u 1 for Y person and the utility or satisfaction is maximized for X person at the point, we have the slope of the indifference curve. It tangent to the price ratio of the two product, cheese and wine.

So, A B here is the price ratio or price line which can be constructed depending upon how much is the market price of cheese and wine and how much is the money going to be spent by the consumer on these two products. So, any point on A B line is called feasible solution. So,

under the given budget constants, consumer X can purchase any bundle of cheese and wine, if it is on the A B line or below the A B line in the triangle O A B.

So, any point lying on A B or below the A B in the triangle O A B are called feasible solution. Like M is feasible, but not efficient because here the entire budget you are not utilized to consume at point M. A B; any point on A B is feasible, but out of the feasible solution, there would be only one optimum solution and optimum solution will be at the point where the MRS; Marginal Rate of Substitution between the two product cheese and wine that is called actually the slope of indifference curve. The slope of indifference curve is equal to the slope of the budget line A B.

So, e is the optimum point; P is not the optimum point. Although P and e provide the same level of satisfaction, but under the given budget constant P is not reachable, P cannot be achieved. Similarly, N provide higher level of utility to the consumer, but N is not obtainable, not reachable because to reach at N more funds, more budget is required and that is why it is outside the budget constant or budget line of the consumer.

So, this is the indifference curve of a X person. Similarly, you can also draw the indifference curve and optimum level of utility taking cheese and wine for Y person and once you get this, then you can superimpose the indifference curves of both X person and Y person and then, you can draw the Edgeworth box. So, this Edgeworth box is shown in this graph and here on horizontal axis, wine is taken and vertical axis, cheese is measured or cheese is taken.

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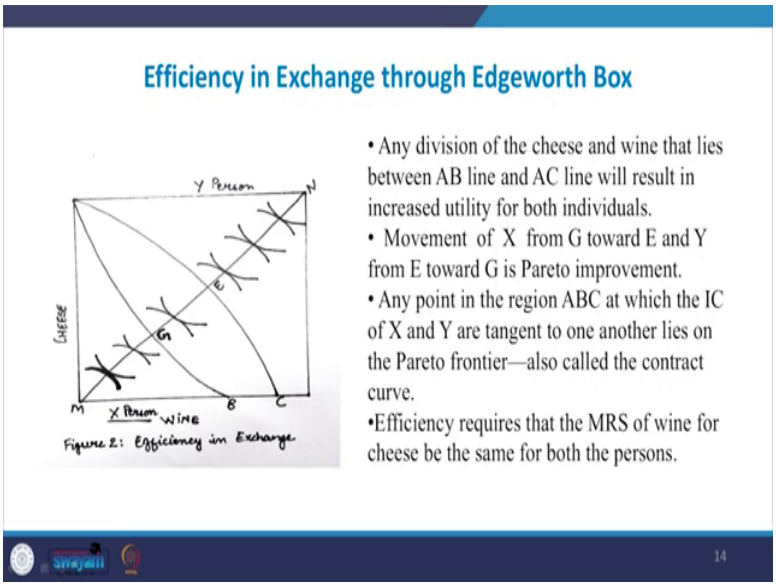

And X persons utility is taken from the horizontal axis below and Y persons on the horizontal axis above. And here, we draw A B that is the indifference curve for X person. Similarly, from upper side you can draw the indifference curve A C for Y person and both curves are convex to the origin because you have to read the A B that is the indifference curve for X from below and then, indifference curve of Y person from the upper side and both are convex to the origin.

Now, if you have a map of indifference curves that are shown in the graph and these indifference curve are tangent to each other. So, Y s indifference curve is tangent to X indifference curve. So, if you draw a line intersecting all the tangent points, then you will get a contract curve. And contract curve is also known as Pareto optimal or Pareto frontier. So, Pareto frontier is here M N.

So, M N is the pareto frontier or contract curve which is drawn by intersecting all the tangent points of the indifference curves of X and Y, when you have a map of indifference curve of X and Y. And these two bigger indifference curve A C and A B shows that there is a larger area, where the utility of both the persons if they exchange each other can be maximized. For example if the consumer moves consumer X moves from G to towards e, then it will be called Pareto improvement because here the utility of X is increased without reducing the utility of Y. Similarly, when Y move from e to towards G then it is again the Pareto improvement because here the utility or welfare of consumer Y is increased without reducing the welfare of X person.

So, if these two persons exchange each other the quantity of cheese and wine, then there will reach at the higher level of satisfaction and that is shown in the middle of these two bigger indifference curve, where there is a tangent point of these two indifference curve and optimization or Pareto optimality will occur on all although on all the indifference curves on the contract curve or Pareto frontier. But actual exchange will be metalized only in the area ABC.

So, any point in the region A B C at which the indifference curve of X and Y are tangent to one another lies on the Pareto frontier and they are called contract curve. So, efficiency requires here that marginal rate of substitution between wine and cheese should be same for both the person and marginal rate of substitution for cheese and wine are same for both the persons at the point, where the slope of both the indifference curve tangent to each other.

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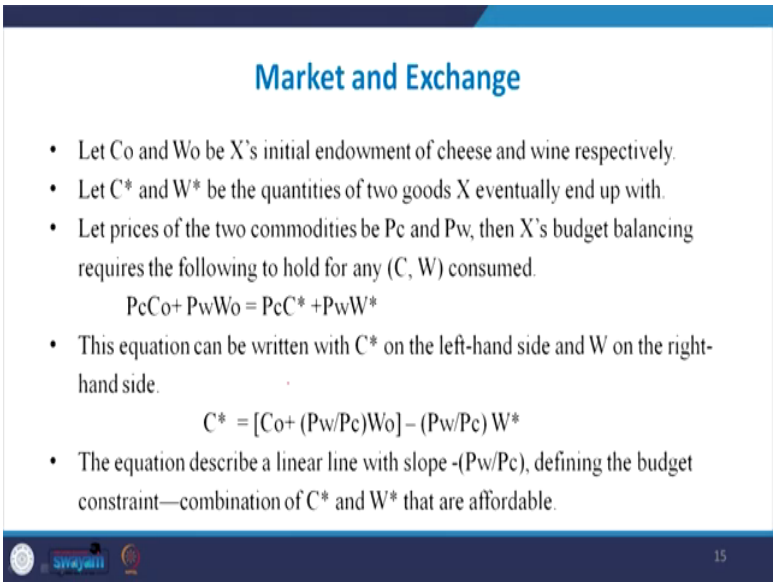

But that is pure, if we want to introduce market; then, we should know how much is the price of these two products. So, let us now introduce market and then, see the exchange of cheese and wine between the two person X and Y. Let Co and Wo be the initial endowment of cheese and wine respectively. Initial endowment means they are having the quantity of cheese and W at the initial level. X is having this quantity; similarly, you can also see the Ys initial endowment. Let X star C star and W star be the quantity of the two goods X eventually end up after the trade. So, after the change the C star and W star are the quantity which will be received by X.

Let prices of two commodity be Pc is the price of one unit of cheese; Pw is price of one unit of wine and we can now make X budget balancing equation by taking the value of the two products which are having by X for example. Like P if you multiply the initial quantity of cheese available to X with the market price, you will get the value of cheese. So, Pc C0 plus

Pw W0 is the total value of cheese and wine available to the X and that will be actually equal to how much after the trade, the consumer X is having that is P s price of cheese multiplied by a quantity of cheese that is C star plus Pw capital W star.

Since, the amount is not going anywhere, exchange it between the two party. So, this equation can be written in terms of C star on the left hand side and W on the right hand side. Then, we can convert this equation in terms of the quantity of cheese that is actually received by X person after trade that is C star equal to bracket C0 plus that is the Pw divided by C0 multiplied by W0 and that is actually the intercept of the line. And minus Pw divided by Pc that is the slope of the; or price ratio of the two slope of the price line multiplied by quantity of wine actually received by the consumer X after the trade.

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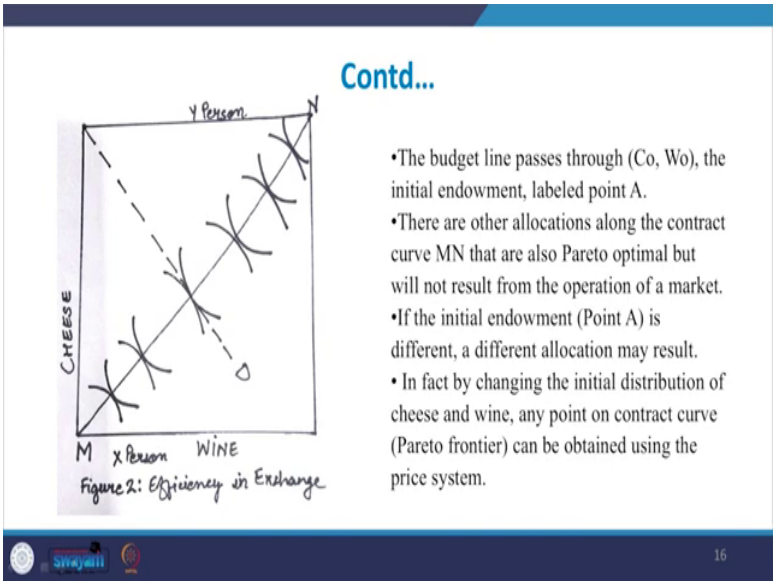

So, this equation described a linear line with slope minus Pw divided by P c. So, slope of the line is negative indicating that there is a trade off between the two. Defining the budget constraints if like combination of C star and W star are affordable on the budget line as I already told you that any point on the budget line is achievable under the given budget constant.

So, in this Edgeworth box, everything is same which we are already discussed, only now we have introduced the budget line which passes through the initial factor endowment and initial factor endowment are at point A, where initial factor endowments are C0 W0 the and they are labelled at point A.

There are many allocation between the contract curve M N that are pareto optimal as I already told you. So, you can take any point on this M N line that is contract curve or Pareto frontier, they are called optimum point. But all optimum point cannot be metalized that depend upon how much is the budget of the consumers or how much actual quantity of the two products are consumed by the two consumers.

So, if initial endowment are at point A is different a different allocation will results. So, in fact, by changing the initial distribution of cheese and wine any point on the contract curve can be obtained using the price system. So, here A D is the price line which is determined on the basis of how much the money is spent on the two products and how much is the price of cheese and wine. And this budget line is having negative slope and this budget line is tangent to the indifference curve of both X and Y. And therefore, three conditions are met here at point equilibrium point.

First, the budget line is tangent to the indifference curve of X person; second, the same budget line is tangent to the indifference curve of Y person and third, the slope or M r s marginal rate of substitution between cheese and wine is same for Y and X person or the slope of indifference curve it tangent of X person is tangent to the slope of indifference curve of Y person. So, that is why it is called efficient combination.

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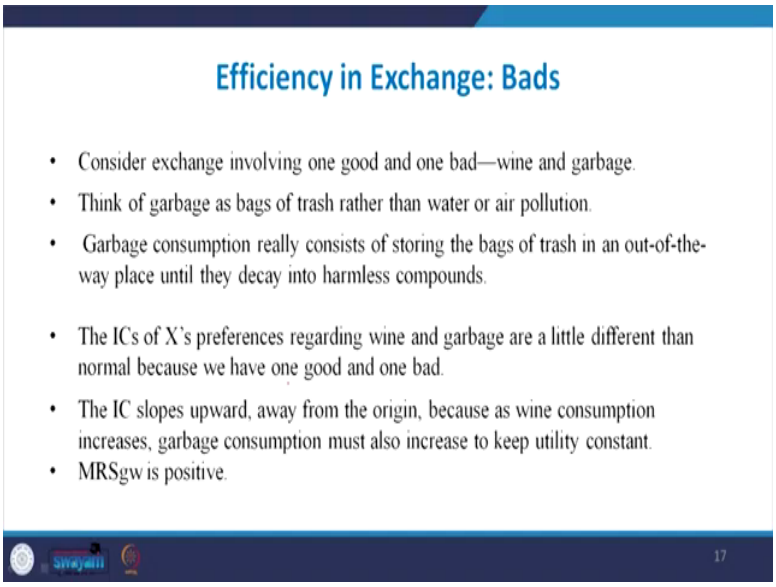

Now, so, these things I think I already uh. Now, if we take the same concept in environmental economics instead of taking cheese and wine, we take one product that is good product and other is the bad product say wine and garbage. If X person is having some bags of dress or garbage and also a bottle of wine, but Y is having nothing. So, can exchange take place or can trade take place between the two? The answer is yes. So,. So, in that case what do you have to do is first you have to draw the indifference curve of X person and indifference curve of Y person.

In this case, since one is good product wine and other is the garbage bad product. So, indifference curve shape would be different unlike the conventional indifference curve which is convex to the origin and having negative slope. In this case, the indifference curve will have a positive slope or upward sloping because if you if you want to keep the utility constant

if you are consuming one more quantity of good product, you have to reduce the you have to consume more of the bad product in order to keep the utility constant.

So, if more wine is consumed more, garbage will be consumed in order to keep the utility constant. But here consumption of garbage does not mean the consumer is directly consuming the garbage. It means that consumer is taking the garbage and simply dispose of. This is the indifference curve of X.

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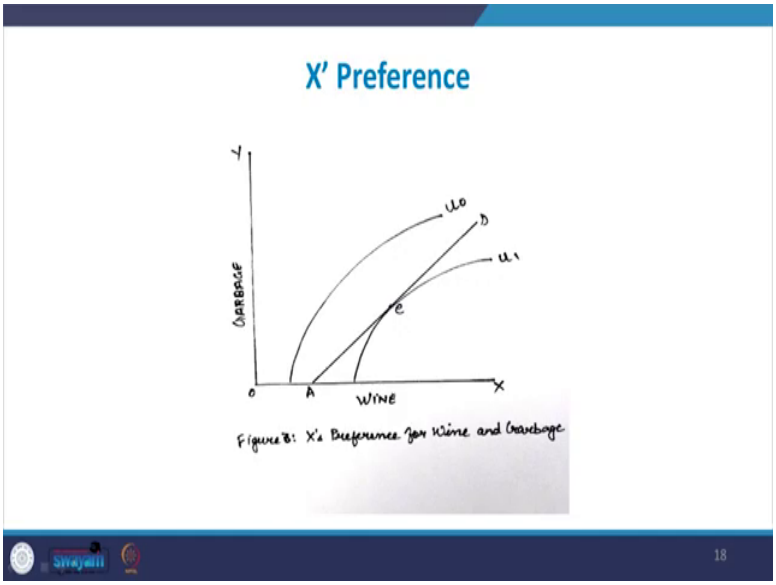

You can see the difference. Here, indifference curve is not a conventional indifference curve because on vertical axis we are taking garbage and on horizontal axis we are taking wine and this u 0 clearly indicate that if you wanted to consume more of wine, you have to consume more of garbage in order to keep the utility constant. So, this is actually the definition of

indifference curve that the given level of utility can be achieved by the consumer using the different combination of two product.

So, given level of utility u 0 can be achieved by the consumer using the different combination of garbage and wine. Now, what will be the optimum combination of garbage and wine that depend upon how much is the price line. So, here price line or the factor of price line budget line or price ratio of garbage and wine, they are shown in the form of A D line. So, A D line is tangent to the indifference curve u 1 and at the point, where this budget line is tangent to the slope of indifference curve optimization will occur.

So, firms this X preference curve u 0, u 1 clearly indicate that higher the indifference curve, higher will be the level of satisfaction and here e 1 is the optimum point, where the consumer is consuming optimum quantity of garbage and wine. Similarly, you can also draw the indifference curve for Y person.

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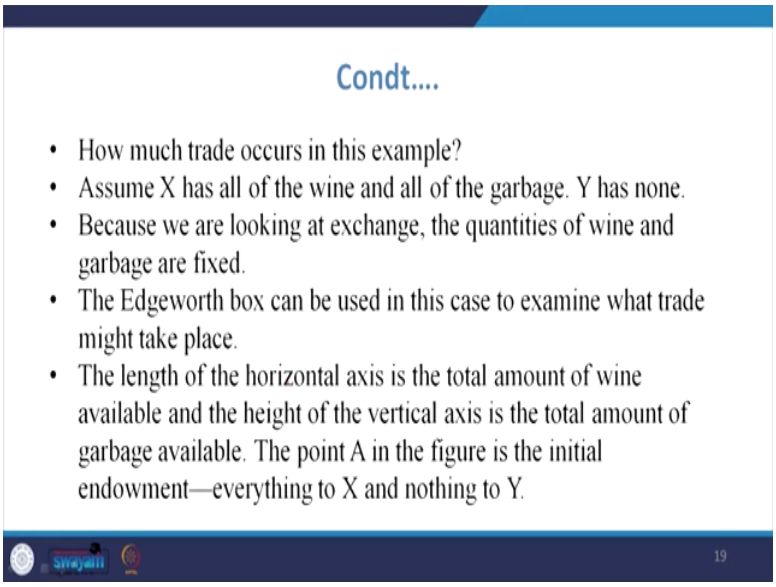

And then, you can super impose these two and then Edgeworth box can be can be done.

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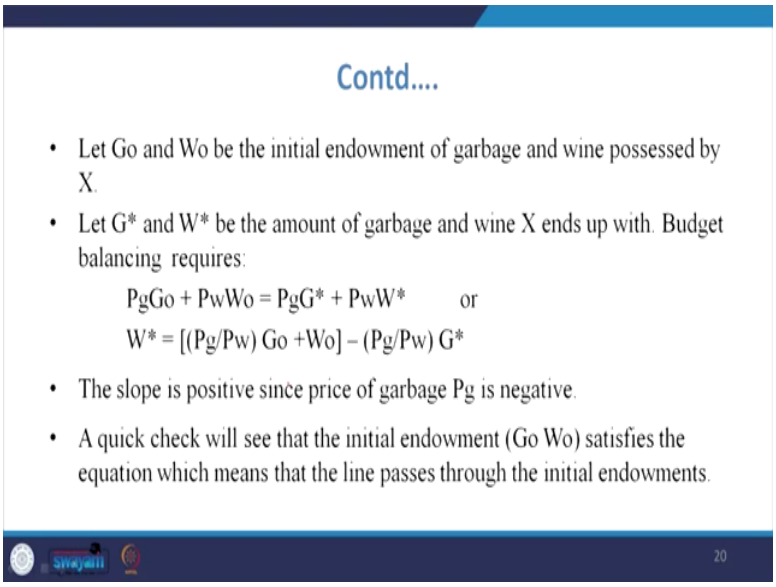

But, let me first draw the budget line and then, we take the budget line and after that we can know the optimum combination just. So, let us take garbage G 0 and W G 0 be the initial endowment of garbage and wine. Let G star and W star be the amount of garbage and wine, end up with the X person after the trade. Budget balancing equation in the same manner can be done here Pg is the price of 1 unit of garbage; G 0 is the quantity of garbage. So, if you multiply the quantity of garbage with price of garbage and try to understand that Pg is negative.

Because garbage is a negative product, no one would like to purchase garbage unless price is paid by the person who is selling the garbage. So, Pg is negative, but Pw is a positive price and W0 is the quantity. So, the amount of money that the X is having in terms of value of the two product are Pg G plus Pw W0 and that will be equal to the actual quantity of garbage

remain with the X person after the trade and actual quantity of wine remain with the X person of the trade that is Pg capital G star plus Pw capital W star.

So, now you can convert this equation in terms of W star and that is exactly the same things. Here Pg divided by Pw multiplied by G 0 plus W0 is the intercept of the budget line and minus Pg divided by Pw is the slope of the budget line and since Pg is negative. So, negative multiplied by negative becomes positive. So, in this case the slope of the budget line is positive; while in case of cheese and wine, the slope of the budget line was negative and slope multiplied by the actual quantity of garbage that is metalized by the consumer after the trade. So, slope of this line is positive since price of garbage is negative.

So, a quick check. We will see that the initial endowment capital G o capital Wo satisfy the equation which means that line passes through the initial endowments of garbage and wine available to the X consumer. So, this is the Edgeworth box prepared in the same manner as we have prepared in case of wine and cheese.

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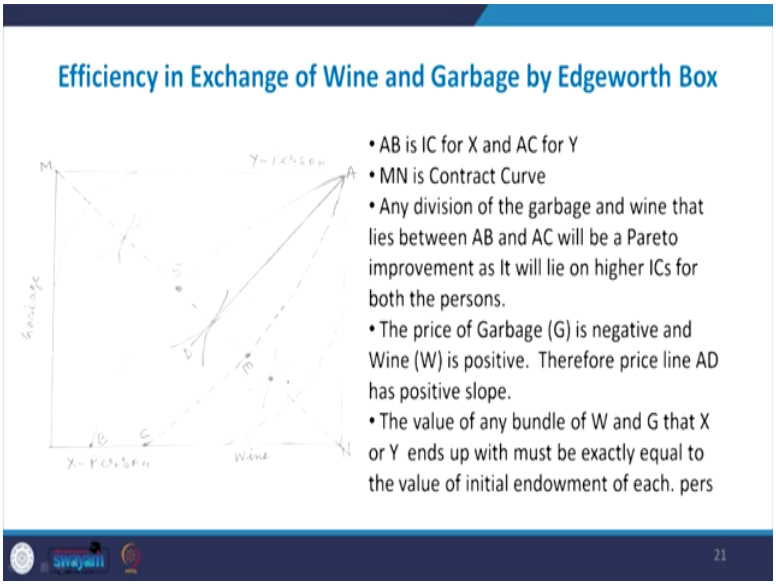

Only difference here is that this indifference curve are not convex to the origin and they are not having negative slope. They are having positive slope because one product is good product and other product is bad product. So, the shape of Edgeworth box is different from the conventional shape of Edgeworth box. So, initial factor endowments are at point A and X persons indifference curve is A B; Y persons indifference curve is A C and the area between A B C is actually the pi which can be distributed between the two depending upon their bargaining power.

So, if consumer X moves from G to e, then it is Pareto improvement and if consumer Y moves from e towards G, then again it is Pareto improvement. But Pareto optimality will occur at the point, where the slope of the indifference curve of Y it tangent to the slope of indifference curve of X and both are tangent to the price line A D. So, this is the equilibrium

level or market efficiency occurs at the point, where the slope of the indifference curve of the two persons in case of garbage and wine are having the same slopes and their slope is equal to the slope of the price line. Let us now sum up. So, let me just tell you in brief what I had discussed in this lecture.

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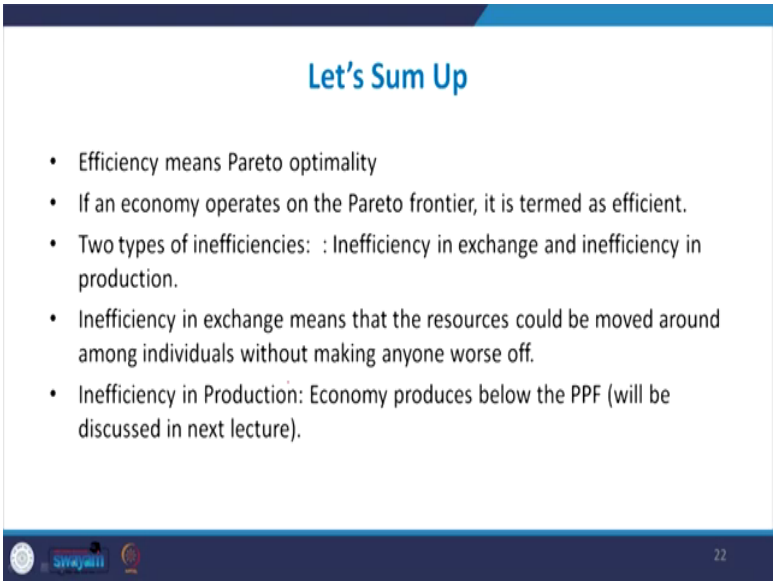

First, I discussed the concept of efficiency. There are three firms of efficiency which I have discussed technical efficiency, allocative efficiency and economic efficiency. Technical efficiency multiplied by allocative efficiency is equal to economic efficiency and economic efficiency achieved at the point, where the isoquant it tangent to the factor price line and at this point all the three efficiencies will be equal to 1. And any point in case of isoquant above the isoquant will be termed as technically inefficient.

Similarly, if any point is below the factor price line will also be termed as allocatively inefficient. Even economy actually operate on the pareto frontier, you can see that the economy is operating at the efficiency level 100 percent efficiency level. And here, I also introduce two types of inefficiency; one is inefficiency in exchange which have been discussed in detail in this lecture and inefficiency in production.

Inefficiency in exchange means that the resources could be moved around among individual without making any anyone worse off. So, if you can make at least one person worse off, if you want to make another person better off; then, you can say pareto optimality is achieved. Inefficiency in production can be discussed through production possibility frontier and this will be taken in the next lecture.

Thank you very much.