Introduction to Environmental Economics

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Lecture - 28
Welfare Effects of Price Change

In the preceding lecture, I explained demand for environmental products. In this lecture, you will study about the Welfare Effects of Price Change; when price of various commodities increase or decreases then it also affect the welfare or utility of the consumers.

As I already discussed in the preceding lecture that when the price of the product increases then the consumer will reach at the lower level of indifference curve lower utility and then in order to keep the utility constant then consumers would be compensated. So, obviously, when price of any product increases that has some impact on the wellbeing of the consumers.

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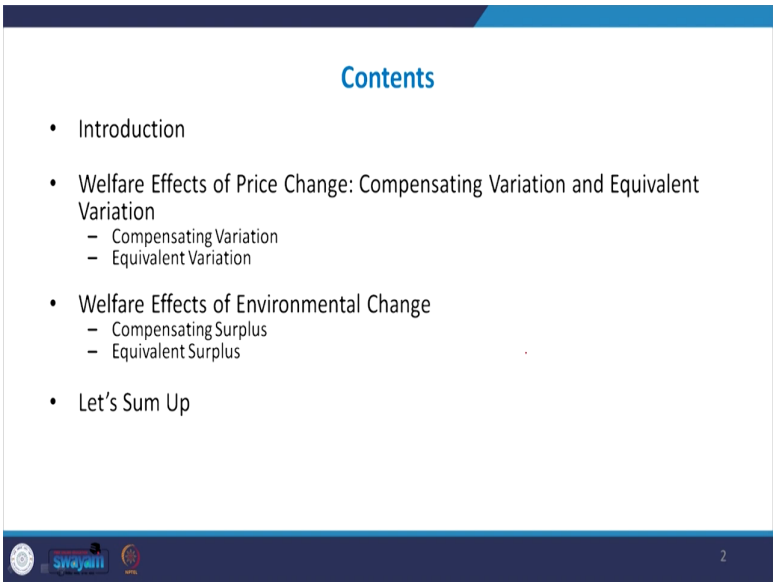

So, in this lecture I will explain you the two concepts: one is compensated variation and equivalent variation, they are very important to know the impact of change in the price of the product on the welfare of the consumers.

After understanding these two concepts in case of conventional products then I will also explain you the similar kind of concepts to know how the change in environmental quality affect the welfare of the consumer. And, these concepts are compensated surplus and equivalent surplus and then we will sum up the topic.

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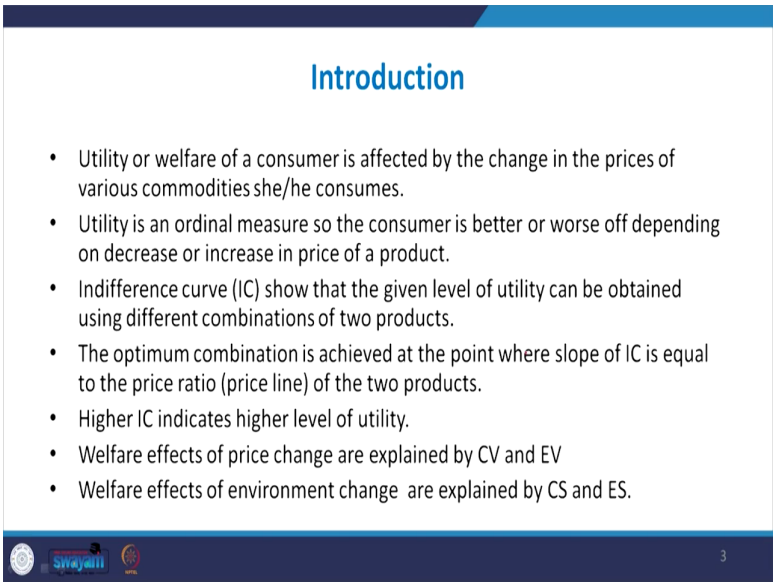

Utility or welfare of a consumer is affected by the change in the price of various commodities he or she consumes. Utility is an ordinal measure. So, the consumer is better off or worse off depending on decrease or increase in the price of a product. So, in economics you have studied cardinal utility approach then ordinal utility approach. So, it is difficult to quantify utility. So, utility is actually ordered.

And I already explained in the previous lecture, how we can draw the demand curve for different kinds of products by using the indifference curve. So, indifference curve shows that the given level of utility can be obtained using different combination of two products. The optimum combination is achieved at the point where the slope of indifference curve is equal to the price ratio or slope of price line of the two products.

Higher indifference curve shows higher level of satisfaction or utility and welfare effects of price change can be explained using compensated variation and equivalent variation and we can also explain the welfare effects of environmental change through compensated surplus and equivalent surplus.

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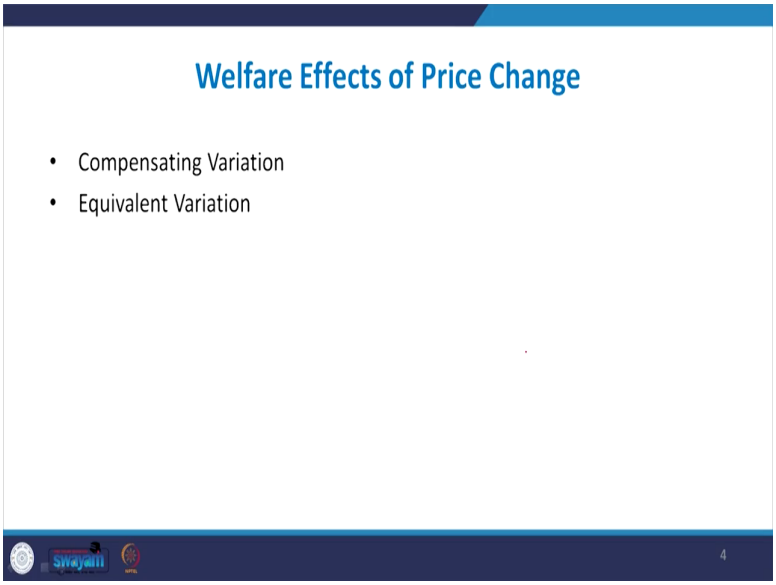

So, let me now explain you the welfare effect of price change through compensated surplus and equivalent surplus.

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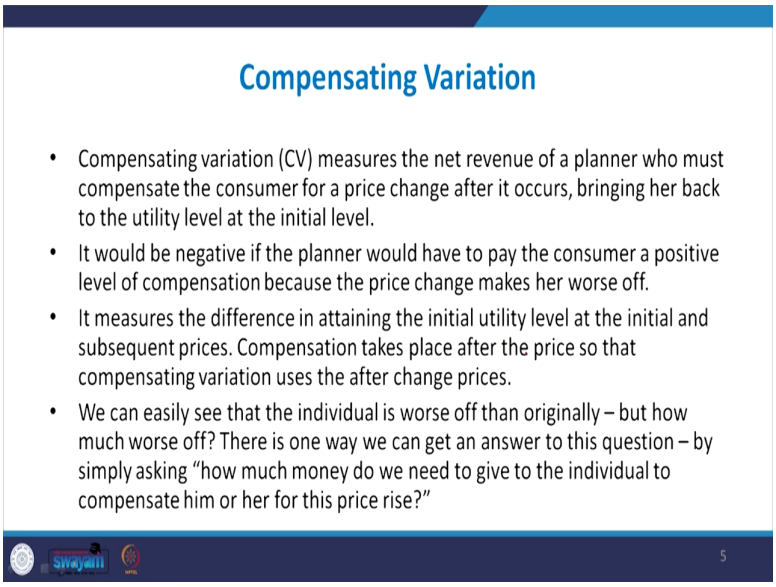

What is compensated surplus? It is measured or it measures the net revenue of a planner who must compensate the consumer for a price change after it occurs bringing her back to the utility level at the initial level. So, when the price of a product increases then consumers level of utility will decline, but if consumer is to be kept neither worse off nor better off then how much additional money is required to be given to the consumer in order to make the consumer neither worse off or nor better off is known as compensated variation.

It would be negative, if the planner would have to pay; the consumer a positive level of compensation because the price change make her worse off. It measures the difference in attaining the initial utility level at the initial and subsequent prices. Compensation takes place after the price so that the compensated variation uses after the change in the price. So, we can easily see that the individual is worse off than the original but how much worse off.

So, when the price of the product increases in the market then consumer is not able to maintain the same level of utility and consumer become worse off. Now, issue is how much worse off? This how much worse off can be accessed on the basis of compensated variation.

So, there is one way we can get an answer to this question by simply asking how much money do we need to give to the individual to compensate him or her for the price rise. So, when price increases welfare of the consumer goes down, then how much money we should give to the consumer so that the consumer can maintain the same level of utility same level of welfare that is exactly known through compensated variation.

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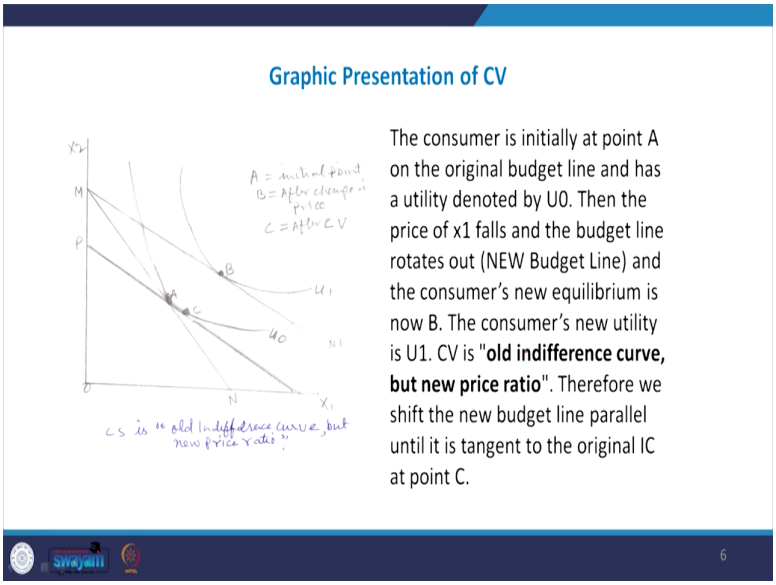

I can explain this compensated variation through this graph and in this graph we have one indifference curve initial indifference curve that is U 0 represented by utility initial level of

utility. And, equilibrium of the consumer is attained at the point where the slope of price line and price line is MN.

The slope of price line is a tangent at point A. So, equilibrium or optimization of utility is achieved at the point where the slope of indifference curve is tangent to the slope of price line or price range the two product x1 and x2. Now, if the price of the product falls, price of x product falls and the price of x2 remain constant and amount of the money spend on these two products x1 and x2 also remain same.

So, there is no change in the income level of the consumer no change in the price of x2, but price of x declines falls and; obviously, when the price of x falls slope of the budget line or price line will change and now new budget line is MN1 which is tangent to the higher level of indifference curve represented by utility 1. And, now the consumer is in equilibrium at point B where the slope of budget line, new budget line is tangent to the slope of second indifference curve that is U 1.

So, obviously, when the price of the product falls, consumers welfare increase, consumer reach at the higher level of satisfaction. Now, if you want to keep the consumer neither worse off nor better off, then what you have to do? You have to cut down the income of the consumer that can be spend on two products, in such a manner that the new price line or compensated price line each parallel to the MN1 budget line, means, price ratio has changed after the decline in the price of the x1.

So, new price ratio is same, but the budget line is parallel to now the new budget line and this compensatory budget line, it tangent at point C on the initial level of utility curve. So, moment from A to B in this graph is due to change in the price of the product. So, when the price of the product change, welfare of the consumer improves and consumer reach at the higher level of satisfaction.

Now, if you reduce the budget of the consumer to be spend on two products then the new budget line which is parallel to the MN 1 line is now tangent to point C. So, moment from B to C is due to the fact that now there is a compensated variation or budget is curtailed in such

a manner that the consumers now again reach at the same level of utility. So, consumer is now neither worse off nor better off.

So, now how will you measure the compensated variation? So, compensated certain variation in this graph is represented by the vertical distance shown by PM. So, PM or MP in the graph is compensated surplus and you can easily understand it by CV compensated surplus is all indifference curve, but new price ratio.

So, new indifference curve is U1 all indifference curve is U 0. So, if consumer reach from new indifference curve to U 0 and first the new price ratio then it is called compensated variation. So, M P is the amount. Now, you can see it since it on the vertical axis we are taking x2 product. So, by curtailing the budget, not only now consumer is in a position to consume less of x2, but also less of x1.

So, how much quantity now is reduced that is MP and how much is the price of the x2? So, MP multiplied by price of f 2 is actually the amount of money that is known as compensated variation. So, compensated variation is the all indifference curve, but new price ratio. So, all indifference curve is U 0 and now consumer is consuming at point C, initially consumer was consuming at point A when price changes shift to B, but now again come back to C. So, moment from B to C is due to the compensated variation.

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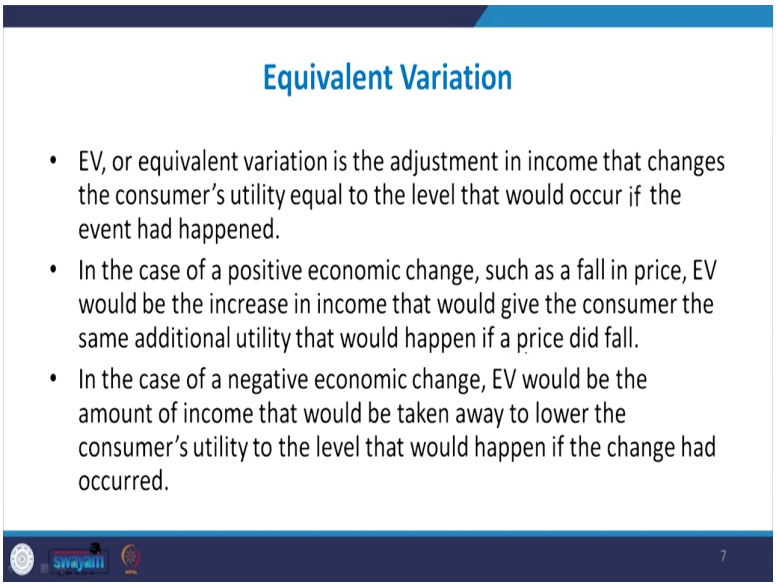

Similarly, you can also explain equivalent variation. Equivalent variation is the adjustment in the income that changes the consumer's utility equal to the level that would occur if the event has not happened. Event here means, price increase or decrease or sometimes income may also be taken into consideration. So suppose, the income level of the consumer declined. So, obviously, the welfare level of the consumer declined.

So, if the event has happened how much the income is to be adjusted to keep the utility at a level is measured by equivalent variation. In this case, in the case of a positive income change such a fall in price equivalent variation would be the increase in income that would keep the consumer the same additional utility that would happen if the price did not fall.

So, obviously, if in our example x falls, but if price of x did not fall then how much additional and consumer want to consume at the U1, how much additional income is required that is

called equivalent variation. So, in case of a negative income change equivalent variation would be the amount of the income that would be taken away to lower the consumers utility to the level that would happen to the change if the change has occurred.

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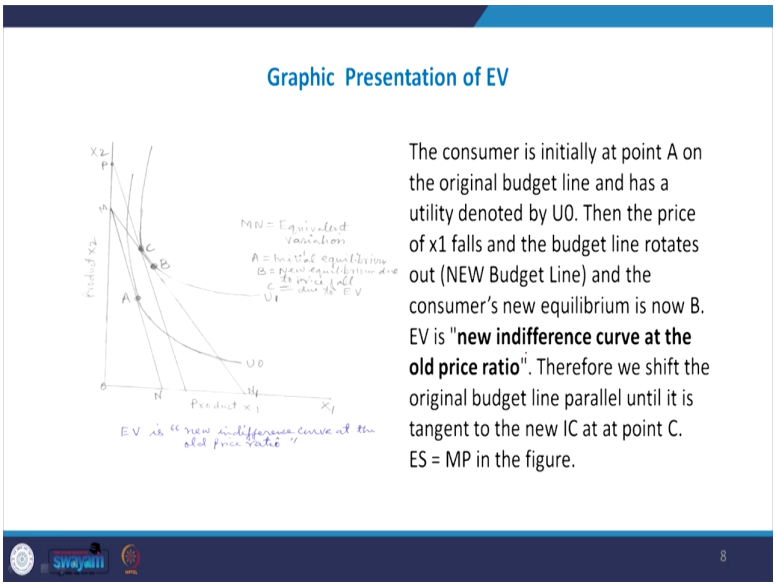

Now, you can see it from this graph equivalent variation. Graph seems to be same as or appears to be similar as we had discussed in case of compensated variation. But, here difference is that in this graph initial equilibrium level is at point A where the initial indifference curve or utility curve U 0 it tangent to the MN budget line. Now, price of x falls, consumer again reach to the high level of satisfaction high level of welfare at U 1. So, moment from A point to B point is due to the change in the price of the product. So, consumers welfare improves when the price of x commodity falls ok.

Now, equivalent variation is the new indifference curve at the old price ratio, just opposite. In that case you can see the initial indifference curve at the new price ratio. So, compensated variation is initial consumer is at the initial indifference curve at the new price ratio but just opposite is the equivalent variation where the consumer reach at the higher level of indifference curve without change in the price; so, if price of the product change did not happen how much money is required to reach at the higher level of satisfaction from A to C; so, from A to C.

So, that is new indifference curve at the old prices. So, therefore, we shipped the original budget line parallel until it is tangent to the new indifference curve at point C. So, moment for; so, ES in this case is again MP, but if you see the two graphs you will find the difference. Now, MP means the additional income, in that case income was reduced, but consumers reach at the higher level satisfaction on the indifference curve, but all price ratio.

So, price ratio is all. So, if you look at the new budget line which is parallel to the MN budget line. So, this compensatory budget line in case of equivalent variation is parallel to the initial budget line and in the previous graph in compensated surplus, the compensated line price line was parallel to the new price ratio. So, this is the basic difference between equivalent variation and compensated variation.

You can to understand better, you can see both these concept together on the same graph. Here in this graph you can see compensated variation as well as equivalent variation.

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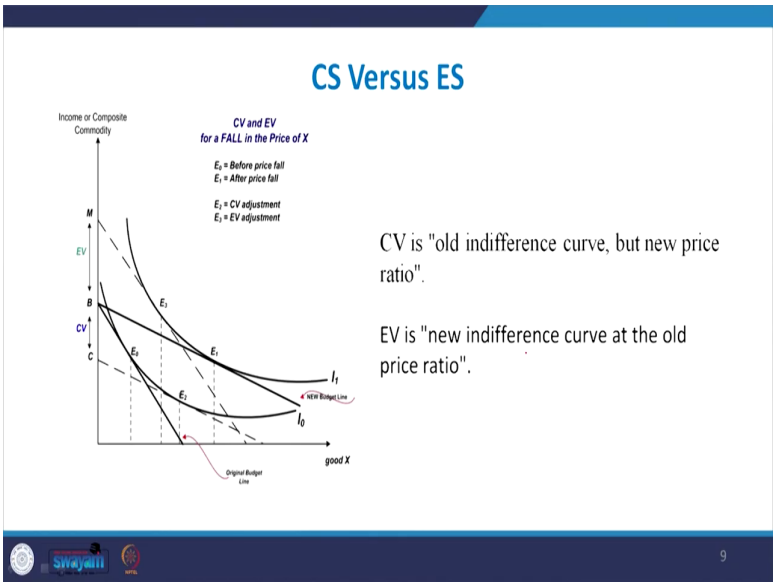

As I already told you, compensate compensated variation is old indifference curve, but new price ratio. So, all in difference curve new price ratio; so, in this graph the point is E 2 from E 0 to E 2; on the same indifference curve consumer is moving from E 0 to E 2. So, compensated variation is BC, you can compare it from the previous graph you will see the exactly same thing.

Now, the equivalent variation is new indifference curve at the old price ratio. So, all price ratio new indifference curve. So, now, the new line is parallel to the initial budget line. So, moment is from E 1to E 3 so, that is MB. So, MB is equivalent variation. So, equivalent variation, so, E 0 in this graph is the equilibrium point before change in the price; E 1is when the price falls, E 2 is compensated variation adjustment and E 3 is equivalent variation adjustment ok.

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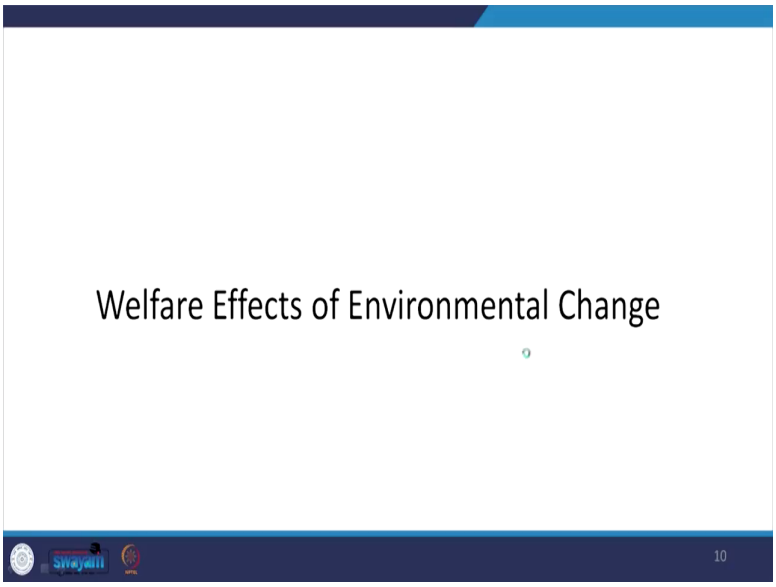

Now, you can understand the welfare effect of environmental change.

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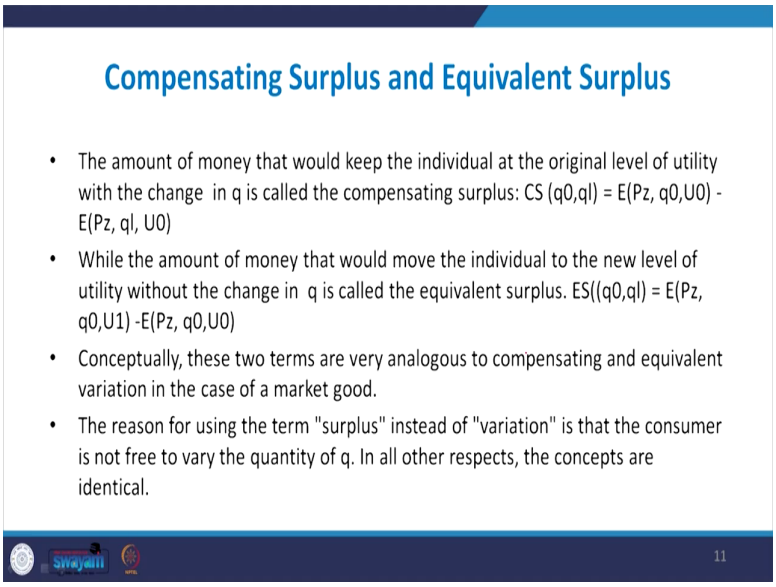

So, the same concept can be applied in case of environmental goods and here we are going to introduce compensated surplus and equivalent surplus to explain the welfare effect of change in environmental quality. So; obviously, as I already discussed environmental quality is also a product and when there is a improvement in environment; obviously, the consumer can save some money on other conventional goods in order to keep the utility constant. So, how much money is shared that is because of increase in environmental product.

Similarly, sometimes there may be deterioration or quality of environment may be declined and it also affect the welfare of the consumer. So, consumer may be happy to take some compensation do in lieu of environmental protection. So, if environment is degraded welfare is degraded also. So, consumer would be willing to take some compensation from the government if environmental quality is deteriorated or reduced.

So, taking these two things into mind you can explain these two concept, compensated surplus and equivalent surplus. Let me first explain the compensated surplus. The amount of money that would keep the individual at the original level of utility with the change in q is called compensated surplus. So, amount of money that would keep the individual at the original level of utility with the change in the quantity of environmental product is known as compensated surplus.

And from this equation you can know the compensated surplus. Here we have the 2 level of environmental quality q 0 and q 1. So, compensated surplus is equal to when there are 2 levels of environment equal to expenditure function with respect to the P z, this is a conventional product and quantity of environmental product which is initial quantity q 0 and initial level of utility.

So, how much money, so, this clearly indicate how much money the consumer is going to spend to achieve the given level of utility. And, now if the quantity of environment shifts from q 0 to q 1, how much amount of the money the consumer is going to spend on z; the difference between the 2 is complete compensatory surplus.

So, while the amount of the money that would move the individual to the new level of utility without change in q is called equivalent surplus. So, equivalent surplus means environmental quality may not improve remain same, but utility may increase. So, how much moneys required for the customer or consumers to reach at the higher level of utility without changing environment is called equivalent surplus.

And, that is represented by the equation, equivalent surplus is equal to when q 0 and q 1are the 2 product expenditure pz q 0 U 1. So, basic difference here is in this case utility change; in the compensated surplus utility is same. So, given level of utility is same, but q is change. But in this case utility change, but q remain constant. So, that is called equivalent surplus means how much money is required for the consumers without change in environment to reach at the high level of indifference curve from U 0 to U1 that is called equivalent surplus.

Conceptually, these two terms are very similar to compensated and equivalent variation which I already explained you. The reason for using the term surplus why we are using here this term surplus in studying the welfare effect of environmental change is that the consumer is not free to vary the quantity of q. So, q is not decided by the consumers. So, q is fixed or q is determined by the public institutions like government. So, in all the aspects the concept are identical.

Now, CS, Compensated Surplus when there are 2 level of environmental product is the compensating surplus are moving from q 0 to q 1.

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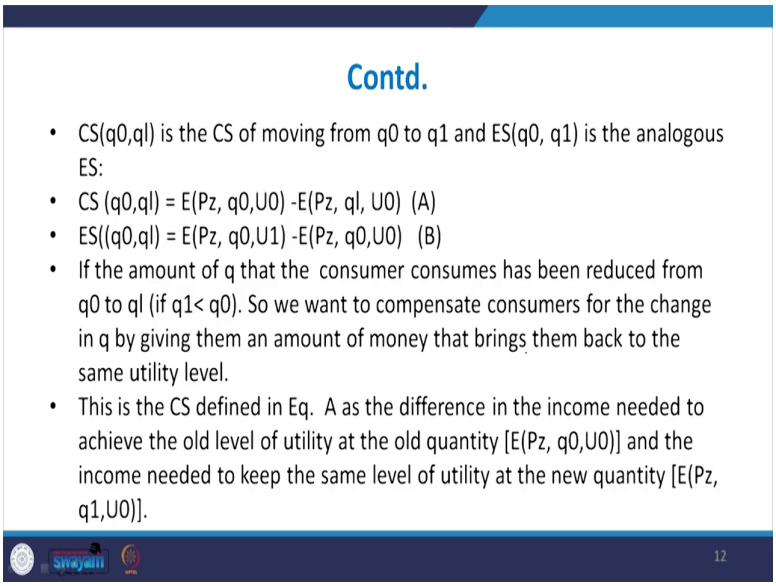

So, if environmental quality move from q 0 to q 1 and equivalent surplus is similar to ES, but difference is, so, from these two equation A and B, you can see the difference between the two. In case of compensated surplus, it is a difference between the amount of the money is

spent by the consumers for given level of utility and initial level of environment minus the amount of the money required by the customers to achieve that given level of utility when there is a change in environmental quality.

So, change maybe or any direction improvement or deterioration. Equivalent surplus is the amount of the money required for the customer to reach at the higher level of utility from U 0 to U1 with the initial level of environmental product minus the amount of the money required for the consumer to achieve the given level of utility without change in the environmental quality.

So, if the amount of q that the consumer consumed has been reduced from q 0 to q 1, it means that quality of environmental product declines. So, we want to compensate the consumer for the change in q by giving them an amount of money that bring back them to the same level of utility.

This is the compensated surplus defined in equation A, as the difference in the income needed to achieve the old level of utility at the old quantity. So, obviously, here the amount of money spent on the z product by the consumers when the utility is given U 0 and quantity of environmental product is q 0 and the income needed to keep the same level of utility at the new quantity where q 0 is moved or shift to q 1, but utility remain constant.

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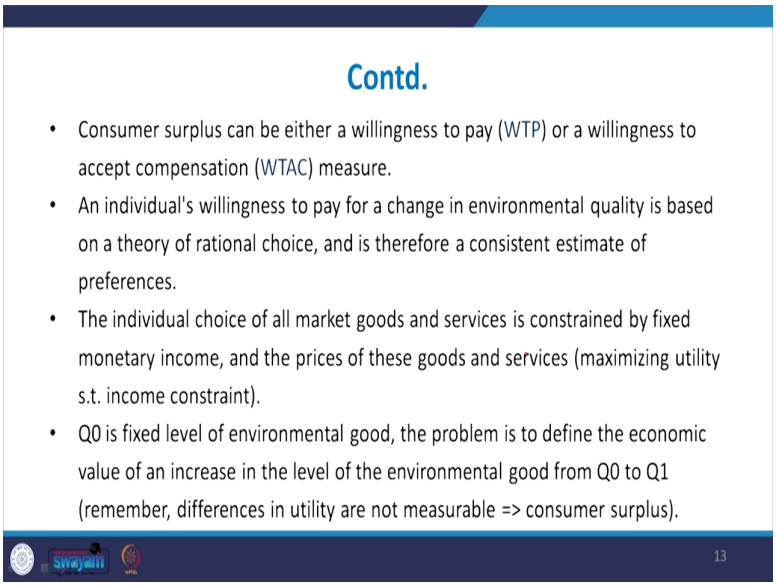

Consumer surplus can be either a willingness to pay or willingness to accept compensation. So, these two concepts are used and individual's willingness to pay for a change in environmental quality is based on the theory of rational choice and is therefore, a consistent estimate of preferences.

Individual choice of all the market goods and services is constrained by the fixed monetary income and the prices of these goods and services and utilities maximize subject to income constants. So, that is what we study in micro economics that budget is constant with the given budget and non-prices of the product we had to take rational choice how much to consume different kinds of products.

So; obviously, q 0 is fixed level of environmental goods and the problem is to define the economic values of an increase in the level of environmental goods from q 0 to q 1. Here,

remember difference in utility cannot be quantified, but you can say in terms of consumer surplus.

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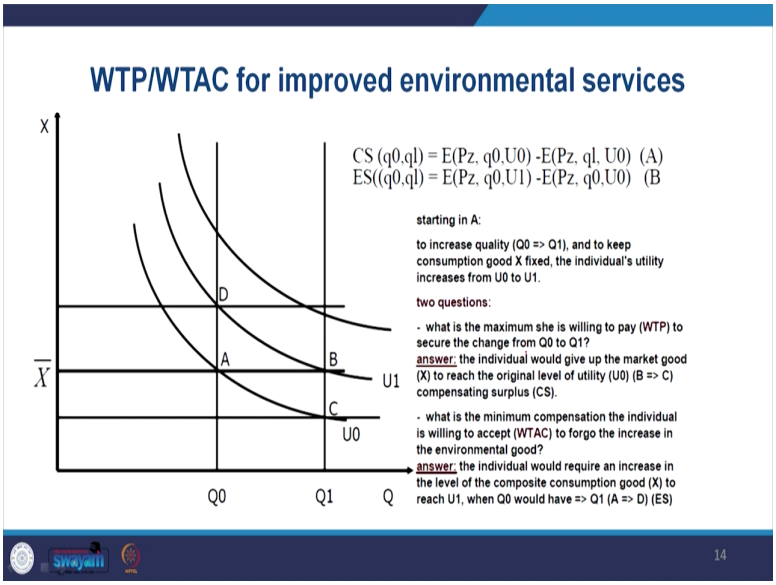

Now, its from this graph you can easily understand the two concept, compensators surplus and equivalent surplus or when there is a change in the quality of environment, how the change in the quality of environment is affecting the consumer welfare can be explained in terms of compensated surplus and equivalent surplus.

I already explained you what is equivalent surplus and what is compensated surplus and difference between the 2 is that in case of compensated surplus, it is a difference between the amount of money spent on the conventional product for achieving that given level of utility when there is no change in the environmental quality minus the amount of the money is spent

by the consumer on z product or conditional product for the given level of utility when they change in environmental quality.

Just opposite is equivalent surplus that is equal to amount of the money is spent by the consumer on conventional product when environment quality is not changed, but consumer reach at the higher level of welfare from the initial level minus the amount of the money that is required for the customer or consumer to achieve the given level of utility with the given level of quantity. So, now you can see from this graph that on vertical axis we are measuring the conventional product say X and on that is the on horizontal axis we are measuring the environmental product say Q.

The starting point on utility curve is A, that is actually the equilibrium point where this entire budget is spent by the consumer on X product and the consumption of X here is fixed and individual utility when increases from U 0 to U1 then consumer reach from A point to B point. So, now, there are two approaches to quantify here how much the compensation should be given and how much is the equivalent surplus.

Here, what is the maximum amount she or he is willing to pay to secure the change from Q 0 to Q 1? So, in that case the individual would be willing to make the goods X to reach at the original utility U 0 from B to C. Actually, here moments from B to C A to B is an improvement in their welfare, but if you want to keep the utility constant under new quantity that is Q 1, then you have to move on the same level of utility from B to c.

So, moment from B to C is compensating surplus. So, compensated surplus is the moment of the consumer from B to C and equivalent surplus is what is the maximum compensation the individual is willing to accept to forego the increase in environmental goods. So, if there is no improvement in environment how much consumer is willing to take as a compensation that is called equivalent surplus and that is from A to D. So, consumer will again reach at the higher level of satisfaction.

So, here if you look at these two equations you can easily understand that in case of equivalent surplus consumer moved from A to D because here the equivalent surplus is the difference

between how much amount of the money the consumer is spending on X product in this graph to reach at U1 without change in environmental quality minus how much amount of the money is required by the consumer to remain at the same level of utility U 0 without change in Q; so, that is obviously, AD. So, AD is the vertical distance that can be known as compensated surplus.

Now, these things can also be compared with the expenditure that really utility U1 at the original quantity without expenditure necessary to yield U 0 at the original quantity, I already explained you all these things.

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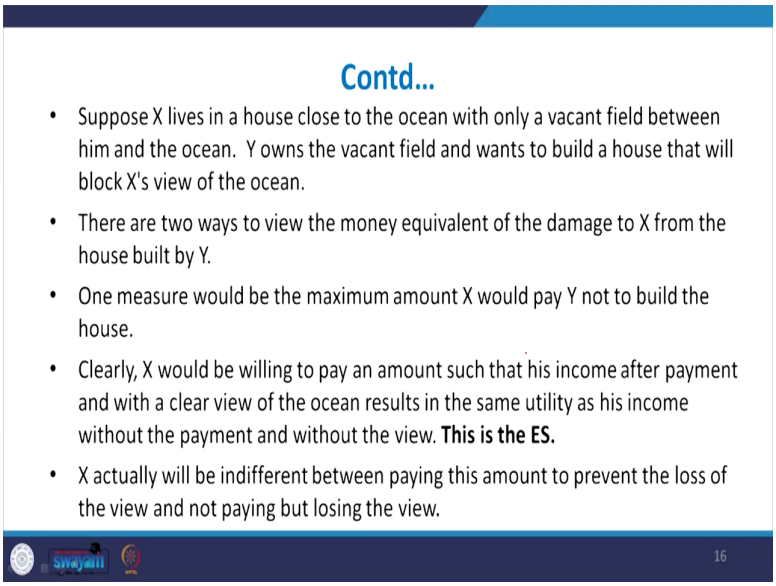

We can also explain this with an example. Suppose, a person X lives in a house close to the ocean with only a vacant field between him and the ocean, but that vacant field is owned by Y person and now Y person want to construct house. So, if Y person want to construct the

house on this vacant plot then sea weaving of X will be obstructed. So, obviously, the utility of X person will decline. So, how much X is willing to pay compensation to Y not to construct house, if ownership of construction house lies with Y is one way to understand the things.

And, second is if in a city law does not permit to construct a house which you obstruct the viewing of others then Y will be willing to pay some compensation to X. So, how much? This can be actually known. So, clearly X would be willing to pay an amount such that his income after payment and with a clear view of the ocean results the same utility as his income without payment and without the view. So, this is called equivalent surplus.

X actually will be indifferent between paying this amount to prevent the loss of the view and not paying, but losing the view.

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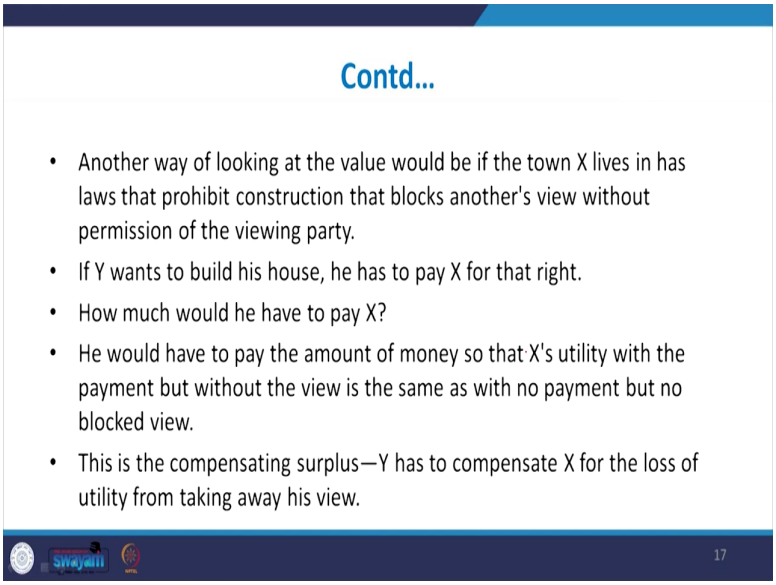

So, another way of looking at the value would be if the town X lives in has laws that prohibit construction that blocks and others view without permission of the viewing party, then what will happen? If Y want to build his house, he has to pay X for that right. How much would he have to pay to X? He would have to pay the amount of the money so that X utility with the payment, but without viewing is the same as with no payment, but no blocked view and this is actually the compensated surplus.

So, compensatory surplus or equivalent surplus can be explained by using this example. Now, let me just conclude this lecture. In this lecture, I explain indifference curve, how indifference curve can be used to optimize the utility of a consumers when consumer is facing a given price line and the utility is maximized at the point where the slope of the indifference curve is tangent to the price ratio of the two products.

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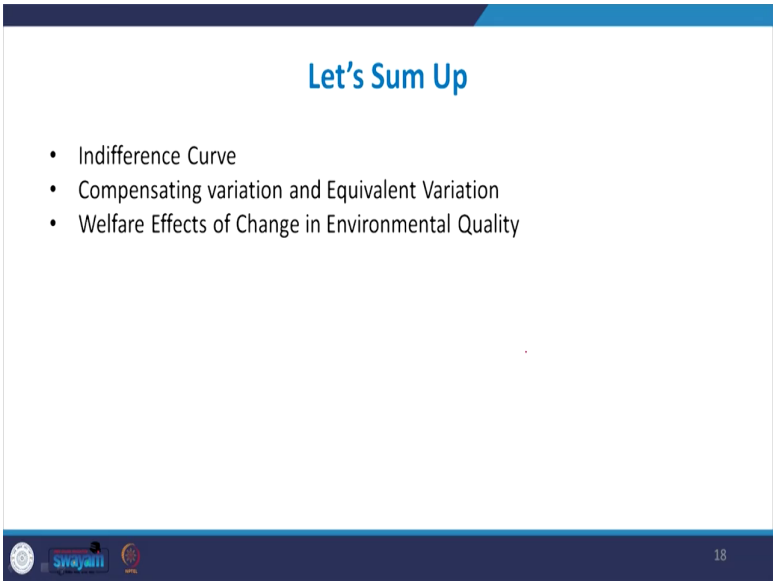

Then I also explained compensated variation and equivalent variation and these two concepts are used to assess the effects of price change on the welfare of the consumer. But since we are studying environmental economics, so, similar kind of concept can be applied to know how the environmental change affect the welfare of the society or welfare of the consumers.

So, here we introduced two concept: compensated surplus and equivalent surplus and we have made a detail discussion on what are the surpluses and how they are affecting the welfare of the consumer.

Thank you very much.