Introduction to Environmental Economics
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Lecture – 32
Averting Behaviour/Defensive Expenditure Method

So welcome back, we are discussing this Averting Behaviour method right and there we are saying that how the our behaviour the why we were changing your behaviour can be expressed in terms of some expenditure like either in terms of time or in terms of the cause incur. And that will be predicting the value of the let us say particular illness or any of the non-market environmental bads.

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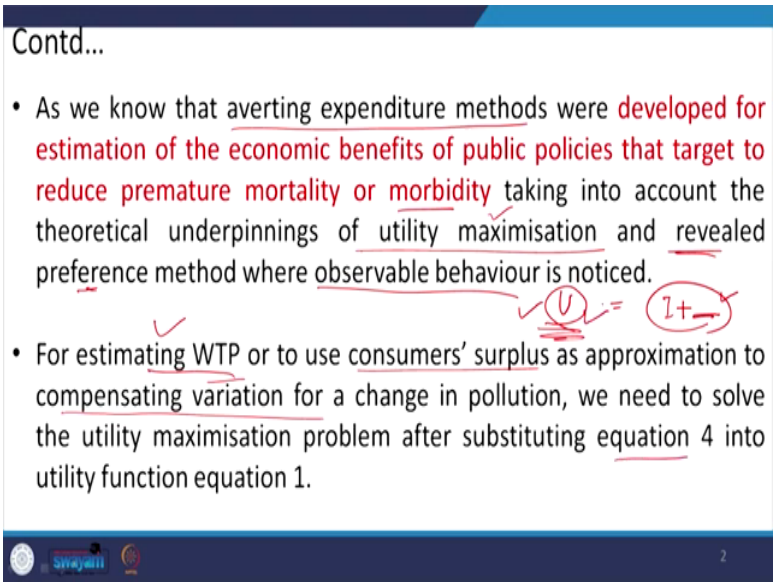

So, in this extend as you understand we are discussing this topic. The very objectives of the topic is to develop to estimate the economic benefits of many policies let us say health

policies that target to reduce the a kind of mortality let us say; let us say premature mortality or the number of times we are falling sick. So, that is morbidity.

So, here in this context we are actually developing a model that is the averting expenditure model based on the theoretical underpinnings of utility maximisation and again this in the predicting variables that express this utility maximisation is based on the observable behaviour. So, that is why it is a part of your revealed preference method. So, that is what we are continuing from.

And in this context what we are; what we have already done? So, we have express the utility functions and we have also expressed the total income constraints that is in terms of income from non-labour source and income from the labour source that we have discussed.

So, from that once this function utility functions and your total income constraint functions are friend. Now, it is our task to estimate the willingness to pay or which is also known as the consumer surplus and this consumer surplus is actually has the theoretical understanding or theoretical synonyms to the compensating variation for change in the particular environment that is let us say change in pollution.

So, if we have to find this or estimate this willingness to pay from these 2 functions that is utility functions and your income constraint what we need to do? We need to solve this utility maximisation problem, that we have discuss in the last class. And then what we have to do? We have to substitute the equation 4 in this utility functions.

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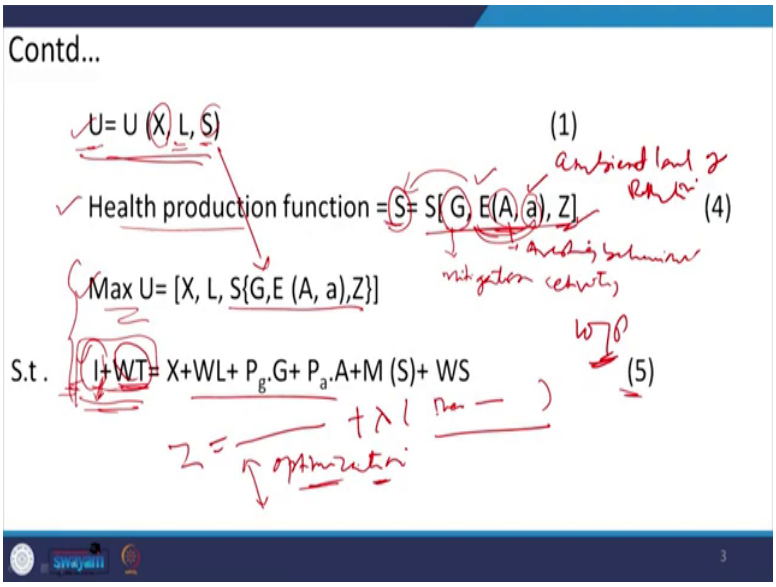

And do not forget that this your equation 4 is your health production functions. So, what we have understand? You know what is the utility function of a particular individual. So, I am just repeating that here utility function of a particular individual depends on the conjunctions is making in X Y Z whatever the goods and service he is doing and also the leisure time that how many times or how many hours the individual is taking rest or a kind of doing a kind of recreations. And at the third one that is essential here is the number of hours or number of days he is falling sick.

So, accordingly the utility function of a particular individual can be final and this is what we have already discussed right. So, based on this utility functions we have also added the health production functions right. So, in health production functions we are saying that when you are

falling sick it is not just like your falling sick without any cause, it has some cause and it is attributed to your behavioral causes right.

So that means, if you are taking enough number of strategies or enough number of precautions, then you obviously the likely the probability of falling sick is less. So, based on this understanding the health production function is made. So, here the health production function is represented as S again the Z the variables which are expressing or which are explaining this S.

So, here G is the mitigating avert or mitigating behaviour or mitigating activity the person is taking in order to avoid and the sickness. And again E is the exposure from the pollutions and here we are assuming that the if a person if the pollution degree of pollution or extend of pollution is high, then it is very high that the person will be falling sick.

And to express this exposure again we have taken into account to other variables one is A and second one is alpha. So, what is this A? So, this is the averting expenditures right and this is mitigating activity. We have done drawn a difference between what is mitigating or mitigation activity and this is the averting we have behaviour or averting expenditure that the person is making. And the second one this alpha is the ambient level of pollutions; that means, beyond a particular level of pollutions then if the further pollutions are added then obviously, the person is going to fall sicks.

So, that is what a is explained as the ambient level of pollutions and Z is the other variables are taken into account. We can take some demographic variables or socio economic variable sometimes we can take. But more generally it is the demographic variables. So, that are the age of a person, so if you are young then obviously, the likeliness of falling sick is less and it depends upon here it is only.

So, that we have discussed. So, now, based on this understanding what we have to do? We have to maximize this utility functions right if you have to find out what is the willingness to pay in this context.

So, in order to maximize this one this utility functions. So, what you can do? You can actually say you are just replacing or substituting this S the value of S here. So, it is done X L and for these this one is substituted. So, your utility function is done and if you have to make maximize, then we need to see what are the constants.

So, these are the constant, this is the constant in terms of the total income constant. So, as you understand we already have explained it that this total constant is the total income constant is the income from non-labour source. So, that is in terms of I and W T is the income from the labour right. So, that means, a person is doing some kind of a labour and he is getting the returns other wises and that is the portion of his income and this portion of income is not actually from the labour. So, it is from a fixed kind of kind of income he is getting may be his getting some interest on his fixed deposits so.

So, again this we have already explained right. So, this is the income constant and taking into account both these what you can now do? So, the task is now yours. I am not going to detail that how it is solved. So, what you can do? You can actually take this optimization functions or by taking this optimization strategies you can solve this functions right and we can use this Lagrange multiplier in order to find this function.

So, let us say suppose Z is this utility functions plus lambda plus this income functions constant minus this one. So, again the rest of the things you can solved by this optimization method.

So, here what you want to say that we can actually find the willingness to pay or what is known as the compensating surplus or consumer surplus here. So, avert from these at this arithmetic exercise of doing this defensive expenditure and what is the impact of defensive expenditure on the well being of the person if he or she takes some this kind of some changes in the behaviour, then in this context we can actually take some other exercises that how the defensive function would be looking like if the level of pollution itself increases.

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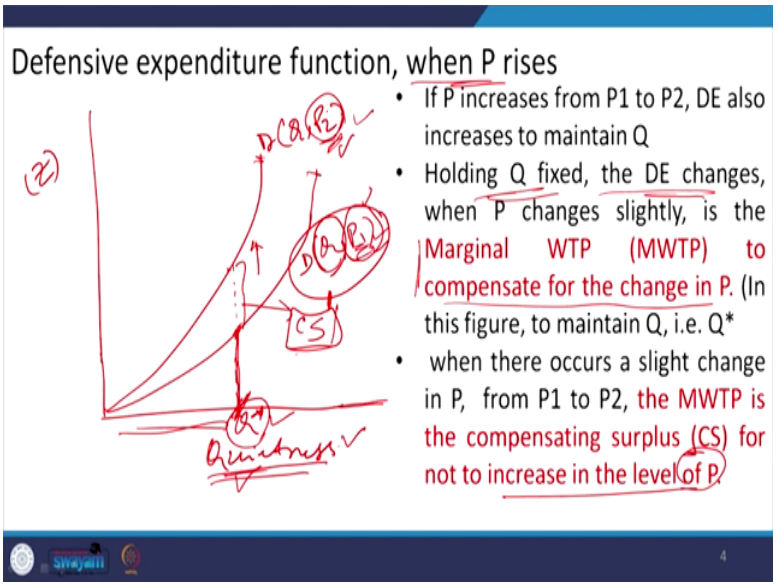

So, let us say the initial we can graphically represent it. So, let us say in the horizontal axis we are measuring quietness; that means, no pollution. So, it is it may be a case of your sound pollution or noise pollutions and the vertical axis we are measuring in terms of the monetary units. So, that means, how the person or a household is measuring quietness and that is why what is the amount he is willing to pay in order to half quietness or in order to decrease the level of pollutions. So, that is what are the basic objective is.

So, here what we can do? We can actually draw the defensive expenditure function initially let us say this is the defensive expenditure functions when the pollution in the initial case of pollution. So, this is this can be represented by defensive expenditure of Q and P1 if the level of pollutions.

So, now what we are saying that our understanding is that when pollution changes right then what is happening to your defensive expenditure and from that how you are going to find the willingness to pay or compensating surplus right.

So, here what we are saying that pollution changes. So, when pollution changes then definitely this defensive expenditure will be moving upward right. So, here let us say the defensive expenditure now would be explained in terms of D of Q P2 right and the individual would be interested in a particular quietness right.

So, let us say it is represented in terms of Q star ok. So, earlier given this defensive expenditure functions or given this given his demand for this quietness Q and P1 level of this pollution the individual is interested to consume at least this level of quietness inside the house right. And now you are saying this the noise the pollution has increased and that is why and obviously, the individual would be interested to maintain the same level of quietness he is not going to compromise the level of quietness right.

So, for that reason what would be his defensive expenditure in order to maintain the same level of quietness that we are we are discussing. So, here we are saying that when we are interested to consume the same level of Q that is in terms of Q1 sorry Q star, then the defensive expenditure would obviously, change right. And when you are saying this pollutions are P is changing very slightly very minimal changes occurred in the pollutions, then we can actually say that the marginal willingness to pay to compensate for the change in P. What would be the marginal willingness to pay to compensate for the very slight change in P that we can find out right.

So, in this figure we just want to maintain this Q1 itself and when you are saying that this pollution is increasing, then the marginal willingness to pay would be equivalent to your compensating surplus for not to increase the level of pollution itself. So, that means, now the households would be actually the compensated or they would be actually trying to made some extra expenditure right. So, that the pollution itself would not be increasing.

So, for that case if we have already drawn this 2 defensive expenditure take into account the initial level of pollutions and the increased level of pollutions from the very defensive expenditure functions itself we can found out what is the willingness to pay or which is also known as the compensating surplus. So, that means, this area the difference between these 2 area would be the compensating surplus or willingness to pay that the household is now willing to pay in order to decrease the pollution level or in order to how the constant environmental quality that is quietness inside the house.

So, although the individual is the individual cannot actually influence this P are pollution outside, but he what he can do is to control the quietness inside the house. So, that is why he needs to do this exercise that what is the amount of willingness to pay he is prepared in order to maintain the same environmental quality that is this much of Q star of environmental quality right. Although he cannot actually control this P1; P1 will be changing or increasing P1 from P1 to P2 level right. So, this is how can say that when the pollution or any kind of environmental quantity or quality whatever we are focusing they are changing, then accordingly the defensive expenditure function would be changing and from this defensive change in defensive expenditure function we can find out what is the marginal willingness to pay or which is known as the compensating surplus for the change in the environmental quality.

So, now will be trying to link that how this defensive expenditure and marginal willingness to pay or what we are saying willingness to pay is related or how it can be actually correlated?

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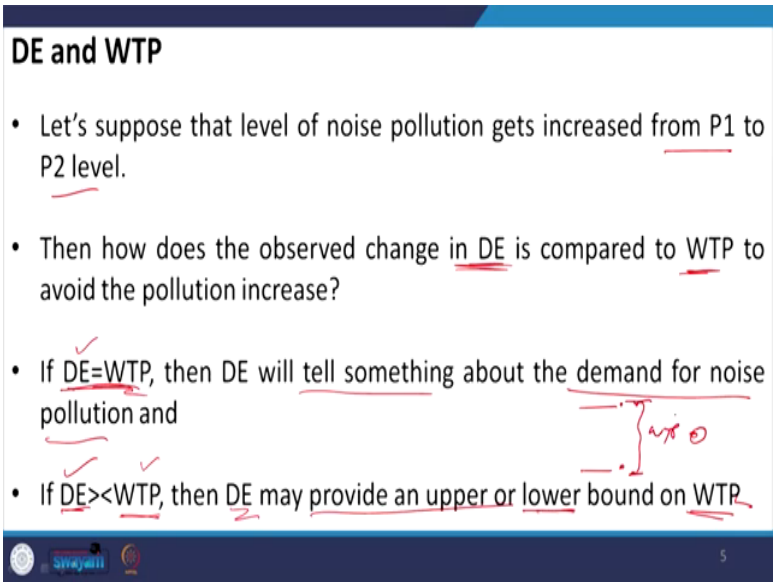

So, when you are saying that because of this pollutions let us say we are in this context we are discussing this noise pollutions then the pollution level is increased from P1 to P2 level, then the question is how does the observed change in this defensive expenditure because defensive expenditure function shifts upward. How this change in this defensive expenditure is compared to the willingness to pay in order to avoid this pollution increase?

So, that means, here we are saying we are trying these 2 things defensive change in defensive expenditure and the willingness to pay. So, some first say this defensive expenditure is just equivalent to your willingness to pay right.

Then obviously, when you are saying defensive expenditure is willingness to pay, then this equivalence is expressing the demand for the noise pollution of that particular household.

What is the demand? Obviously, the amount he is he is doing or spending in terms of defensive expenditure and that is what is equivalent to willingness to pay if it is so.

But it is not necessarily that this defensive expenditure would be equivalent to willingness to pay. Sometimes what happens willingness to pay may be greater than this defensive expenditure amount because as you understand from the very beginning we said that when you are going to do some mechanisms or install some mechanisms in order to avoid this noise pollution outside and we need to maintained the quietness inside.

So, may be this equipment is not 100 percent successful in compacting the noise pollution from outside right. So, in that case although the noise pollution or the quietness can be controlled, but it is it cannot be controlled as for our expectations. So, in that case this defensive expenditure may be less than the willingness to pay or willingness to pay may be greater than the defensive expenditure right.

So, in these conditions if it is so like let us say this defensive expenditure the amount of defensive expenditure is greater than willingness to pay. So, that means, you are actually making more expenditure on this defensive mechanisms done what you are willing to pay.

So, in this case it will be providing an upper limit of this willingness to pay itself right. Because we are not saying that willingness to pay is this amount this number, we are actually talking about given the change in the environmental qualities. This willingness to pay will be ranged from this to this because the scenario would be different right.

So, here we just want to make this theoretical think that this defensive expenditure if it is greater than willingness to pay then; obviously, this defensive expenditure will be providing an upper limit or upper bound for the willingness to pay. And if this defensive expenditure is less than the willingness to pay, then it will be providing the lower bound on the willingness to pay. So, that means, you are in this case will be finding the limits of willingness to pay itself.

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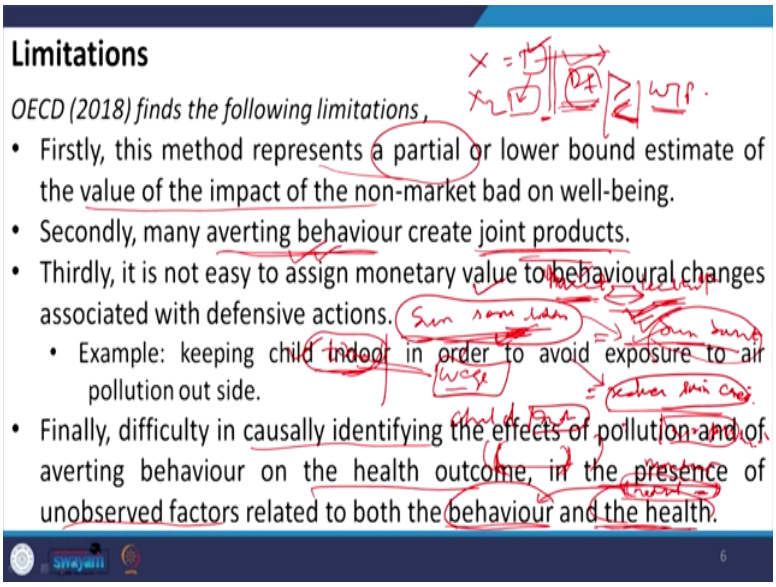

However this defensive expenditure method is not free from limitations. So, there are some limitations that have been identify this research by OECD in 2018. So, firstly, we can say that this method actually presents a partial or lower bound estimate of the value of the impact of non-market bad on the very individuals well being.

So, why we are saying because when we as saying this defensive expenditure can be greater than or less than the willingness to pay right. And generally we are saying this defensive expenditure from the because again this is a revealed preference method and from our own observations from the literature that we are finding that although theoretical this is possible, but whatever our literature states that this or observation states that this defensive expenditure is generally less than the willingness to pay right.

So, that means, this mechanisms of valuing the impact of non-market bad on the individuals well being. It is actually representing some partial phenomenon partial thing. It is not completely giving the picture or completely estimating the this is the value that the individual is actually putting for the non-market bad. And, secondly when you are actually discussing many examples real life examples of averting behaviour or defensive expenditure method. So, this averting behaviour itself create joint products.

So, what is joint products? So, let us talk about from our own common observation that when you are saying that meat production right. So, meat production and leather productions are having a correlation; that means, when meat production would be increasing particularly that you are badgering the cows right, then this meat production would be increased and also the leather production would be increased.

So, the second phenomenon can be understood from the fast phenomenon or fast phenomenon can be understood from the second from phenomenon. So, this is what we are saying the joint productions, but in case of this averting behaviour case can we give some examples that actually will be best feet for this joint products.

So, you can just think about, but we can discuss that when the averting behaviour just like you are saying you are using sunscreen lotion. Why we are using this sunscreen lotion? Because you want to avoid the sun burnt, you do not want it right.

And it is the other impact would be what we can reduce the skin cancer. Do not you think that a flying are using this averting behaviour expressing this averting behaviour and then doing this averting expenditure it is it is producing 2 products. One is you can save your skin from sun burnt in the short run and in the long run you can reduce the skin cancer.

And most of this averting behaviours their creating this kind of joint products, but the issue is that if you are interested only in your policy analysis is only concerned about the sun burnt right, then you cannot actually explain this one the how this the same application or same expenditure can reduce the skin cancer right.

So, we need to actually take into account how it can be apportioned. So, this is again a task or limitations in this method that how it will be proved. How can say that this is this expenditure is this expenditure you are doing only for the sun burnt in order to avoid the sun burnt and this expenditure this portion of the expenditure is only done in order to reduce this skin cancer right. So, this is what this is a challenge.

And thirdly you can say that it is not easy to assign the monetary value to our behavioural changes and that is associated with your defensive actions. So, it is very difficult to actually assign the monetary value always. Let us say you are saying the case of time. When you are saying this averting expenditure a defensive behaviour, so it can be in terms of either time or in terms of actually doing purchasing some goods or techniques or some technology to avert the particular environmental bad right.

And when basically it is this averting behaviour is expressed in terms of time right, then you are saying that this time can be actually monetized expressed in terms of monetary valuations by taking into account the value of time for those individuals. So, that is in terms of wise.

So, how many of wise hours are lost because of taking this averting behaviour and that is why how many how what is the amount of wise lost because you have practiced is behaviour or change your behaviour. But, in case of in the last class we discuss about this thing that when you are saying the children are generally kept indoor in order to hour the air pollution right.

And let us say the we know that from the from very different sources we got to know that this is the peak hour for the pollution and that is why the children should not be exposed to the outdoor. So, we are trying to keep them inside the house right and when they are not going to the outdoor cases or they can actually at that time they could have their own recreational activities outdoor, but they are bound to be inside the house right.

Then how this time would be measured? Can you measure can we express this explain this in terms of this monetary units? Because children do not on anything, you cannot say that the wise for them is this much no there is no nothing. So, this is the same logic applicable for the

old age or retired person's right. So, that is why you can say that it is not actually easy to assign this monetary value for any kind of behavioural changes that is associated with the defensive actions right.

So, the last, but not least you can find so many other limitations that we are not actually discussing here. So, here we just want to say that in case of the presence of some of the unobserved factors right that actually related to the behaviour the very averting behaviour that we are changing or and it is also related to the outcome of this averting behaviour that is in terms of health outcome right. And here we have taken some variables that are explaining this variables and some other variables that we are not taking to account; that means, they are unobserved right.

So, in this case if some of the variables are unobserved they are not taken in your model or they are not taken into account while predicting what will be the how the individual will be valuing because of this bad. So, in that case it will be difficult in causally identifying the effects of the pollution and on the health outcome.

So, for example, we can say that it is the case. So, we can actually extend the same example of children's they are actually kept inside right and we know that some children they do have good immune system natural they do have this natural capacity to bear this pollutions.

And some of the children they are actually weak they cannot actually tolerant if they are express to the pollutions right. But, these natural systems right that is in built in the children itself they vary from children to children, but how this unobserved value or un unobserved variable that is the natural immunity systems which is impacting the behaviour itself the behaviour that suppose say X children X child his strong; that means, it is natural immunity system is strong.

So, he can be exposed to pollutions he can tolerate there will be there will be no effect he will not be falling sick. But, still and there is a there is another case X2, so he is actually having this 4 immunity systems. So, as a result when you are actually forwarding doing the same behaviour for both the children they and you are not actually take into account this natural

systems into account and it is actually related to the behaviour as well as the health outcome. So, in that case that is a causality we cannot actually there is a difficulty in causally identifying the effects of the pollutions and the averting expenditure. Sorry, averting behaviour that is in terms of the health outcome ok.

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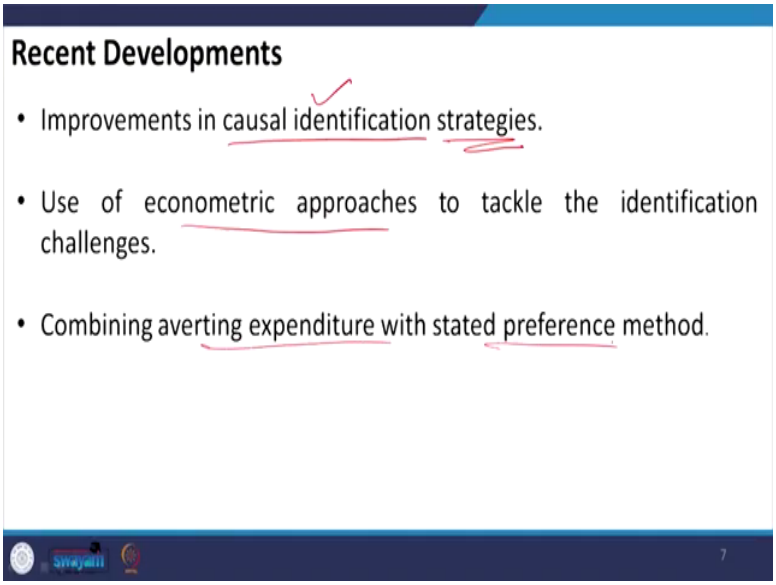

And in this method also we can identify some recent developments right. So, first of all that recently just like just now we have discussed about the causal identification is a problem and recently we actually develop some strategies. So, that we can identify we can address this causal identification problem and moreover some of the econometric approaches.

Now, we have we have developed in order to tackle this identification challenges and moreover in the recent literature we are finding this a there is a combination of averting

expenditure with the stated preference either the contingent value is relation survey or choice modelling in order to valuate this non-market bad.

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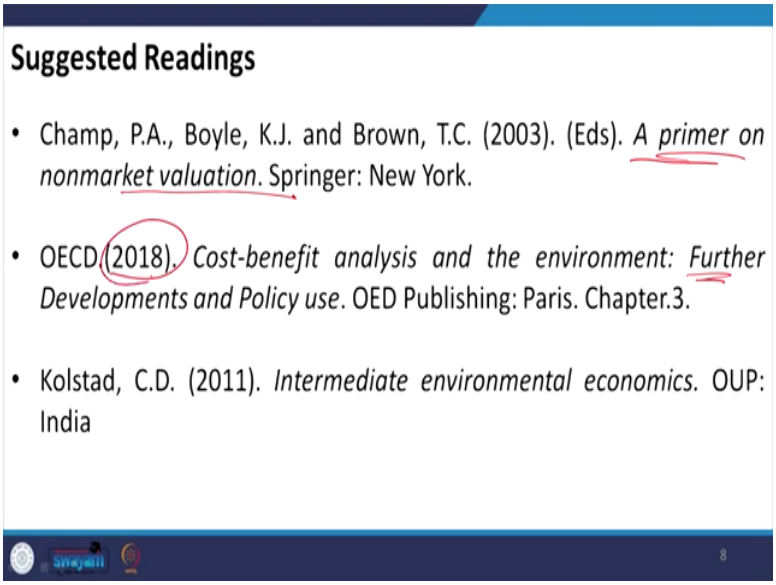

And these are the suggested reading that we can follow. But, you must follow this primer on non market valuations and for the limitations and recent development you can follow this book 2018 book. So, that is all about the averting behaviour method.

Thank you.