Environmental and Resource Economics
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Lecture 44
Economic Valuation of Environmental Goods and Services - Different Valuation Approaches - Part 4

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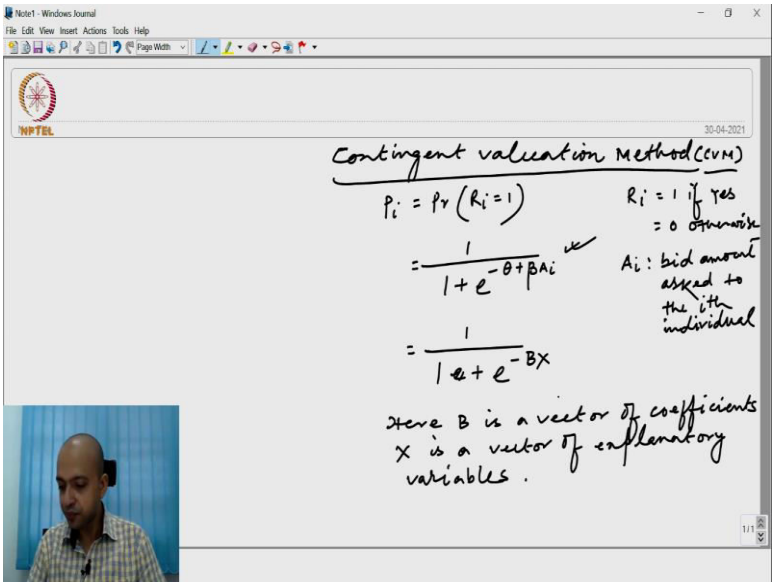

Welcome to our discussion on Economic Valuation of Environmental Goods and Services. And we have started our discussion on Contingent Valuation Method in our last session. So, we were discussing about Contingent Valuation Method. Contingent Valuation Method or in short it is called CVM. And then at the end, we discussed about an econometric model to basically estimate the mean willingness to pay and from their total willingness to pay.

Today's discussion I will mainly focus on empirical strategies that means how will you actually conduct a study to estimate willingness to pay or total economic value or total willingness to pay for some environmental goods and services. And I will also share with you an empirical paper where it is step by step, it is discussed what are the different steps that actually you should follow in an empirical study to estimate willingness to pay for environmental goods and services.

So basically, yesterday, if you recall, we said that Pi is basically equals to probability that Ri equals to 1. What is Ri? Ri is the response function, Ri equals to 1, if yes and 0 otherwise. That means when the individual is asked to contribute a specific amount which we denoted as Ai, then whether the individual will say yes or no. What is the probability that the individual

will say yes for a specific bid amount that is what we are going to estimate by applying the probabilistic model.

Basically, the logit model, what we discussed yesterday. So, this Pi is probability that Ri equals to 1. And that ultimately, we derived as 1 by e to the power minus theta plus beta Ai. Where Ai is the bid amount asked to the ith individual. Now the paper what I would like to share it with you for your better understanding of empirical estimation, what they have derived in their paper is 1 by 1 plus, 1 by 1 plus e to the power minus beta X.

Now here B capital B and X they are all vectors, so B is basically here, B is a vector of coefficient and X is a vector of explanatory variable. That means in the model what we discussed the theoretical model, what we discussed there, we consider only one explanatory variable that is the price, the bid amount, while estimating willingness to pay we have used only one explanatory variable in the regression model, that is the bid amount.

Whether the individual will say yes or no for a specific bid amount, for a specific bid that purely depends on the amount. Higher the bit, lower would be the probability of saying yes. But in real world when we generally conduct this type of study, apart from the bid amount or the price, we also considered the respondents socioeconomic and demographic factors, to determine the probability of saying yes for a particular bid amount.

That is why while in our model it is only beta in the model that is used in the empirical paper which i am going to share with you, they have used capital B which is basically a vector of coefficient. That means you will have beta1, beta2, beta3 dot dot beta k. Similarly, here in this model you have only one explanatory variable Ai while in the paper they have used capital X which is again a vector of explanatory variable.

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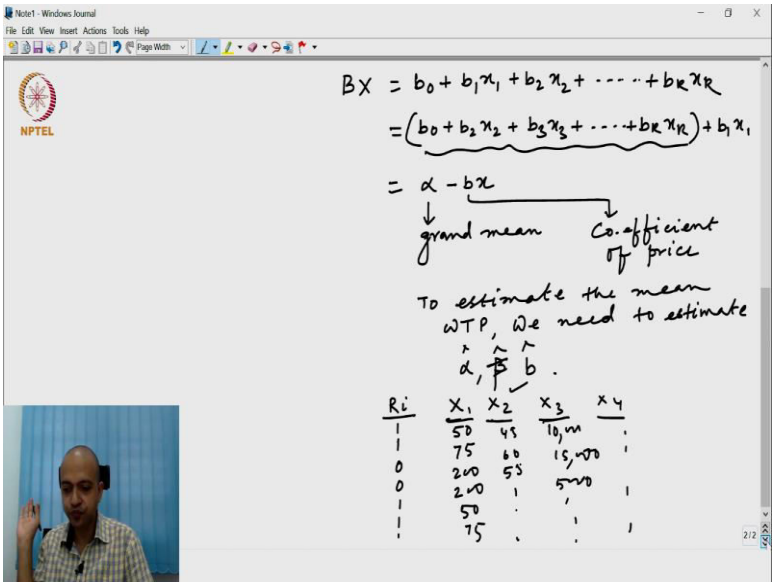

Now what we can write then if we expand this beta X, so beta X is basically then what I can write is that beta 0 which is a intercept plus beta1 x1 plus beta2 x2 plus beta k xk, so if we expand this, we will get this type of result. Now let us assume that in the set of explanatory variable x1, the first explanatory variable x1 is the price and from x2 to xk, these are other explanatory variable other than the price.

So, the idea here is to add the intercept with all other explanatory variable, multiplied with their coefficient, and keep beta1 x1 separately, beta1 x1 separately. So, this would become beta 0 plus beta2 x2 plus beta3 x3 plus beta k xk in one category. And then plus beta1 x1 in another.

Now this summation, when I add this, in the paper or many other econometric literature, it is known as grand mean. So that means here in the model here the intercept is theta in this model. And what I am trying to, trying to make you understand, see in this model there is no intercept, intercept is actually there within the beta x itself, but it is not specifically mentioned like theta minus theta plus beta Ai.

So, after expanding this beta x, what we are getting is this. And they are calling this as grand mean alpha. And then they are calling this one as alpha minus beta x. So, they are calling it minus beta x. So, this is, this alpha is known as grand mean, grand mean. And this beta is actually the coefficient of price, coefficient of price.

So once that means here to estimate the mean willingness to pay, what we need to do, to estimate mean willingness to pay, for mean WTP, we need to, we need to estimate alpha hat, and beta hat. Sorry here it is not beta rather b. I am telling b hat. You can call it beta also that is not a problem, just a notational issue. So alpha hat and b hat, beta hat.

So then, what do we actually do in empirical setup? We need to first identify the environmental goods or service, for which we are going to conduct the valuation. We need to identify the population or the entire set of people, entire set of stakeholders, who are going to get the benefit out of that environmental goods or resource. Then we will collect a sample, a random sample from the population.

Once we collect the sample, so that means, let us say that our sample is collected at the household level. So, we will go to each and every household and ask a random bid amount. And how will you select the random bid amount, if you recall, we have discussed in our previous class, so that should come from some kind of pilot study. Some kind of pilot study wherein we will go and understand their willingness to pay or preference for the environment, then we will select some four bids.

One bid which is called minimum that should be accepted by most of the individual. Another one is the maximum bid. Maximum willingness to pay, that should be rejected by all the individual. And some average bid, around which will take sum two. So that means total will have four bids. We will divide the total number of households by four, and for each bid we will have some, let us say, 50 or 55 or 60 households.

So, we will go to each and every household, will ask would you like to pay rupees 50 for this additional drinking water? The individual will say yes or no. We will record that response, since this is open ended. Our story ends there. If they say yes then we will put 1, if they say 0, we will note down that, no we will note down that as 0. We will also collect; we will also collect other socio-economic and demographic factors from each and every household.

Then we will regress that Ri, that response, so that means Ri would be like this, 1 1 0 0 1 1 1 like this. So, this would be our Ri and then that should be regressed on several explanatory variables, let us say x1, x2, x3, x4, like this, x1 is the price or bid amount, maybe this would be 50, then this is 75, then 200, then this is again 200, then 50 then 75 like that, different bid amounts.

We will ask for each and every individual; x2 is, let us say, age of the household head. So maybe 45, 60, 55 like that you will have; x3 is, let us, say monthly income, some 10, 000, 15, 000, 5,000, like that will have. And then x4 also some other explanatory variable, may be the education level of the household.

So, Ri is the response function x1, x2, x3, x4 these are all explanatory variable. Then we need to apply the logit model that means we need to estimate a logit model. Because the function what we have derived Pi equals 1 by 1 plus e to the power minus beta x, that is nothing but the cumulative logistic distribution function, that is why we need to estimate logit model.

How to estimate the logit model? How to interpret the coefficients for that, I will share some detailed lecture on econometrics of logit model. From that lecture you will be able to understand how to actually estimate a logit model, using a specific software called 'Stata', and then how to interpret the coefficient.

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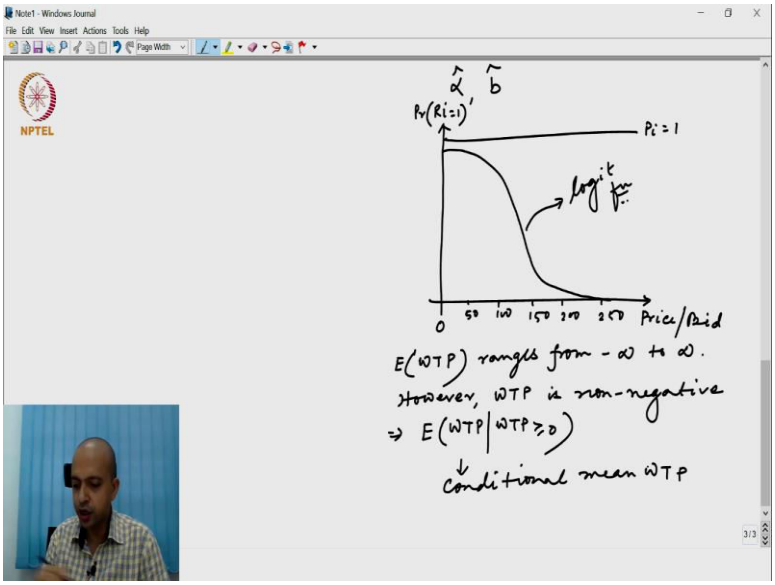

So, once we estimate, once we estimate the logit model, from by regressing this Ri on the explanatory variable, then I will get this alpha hat, and this b hat, alpha hat and b hat. And this logit model this, this logit model, what we have estimated, that it takes a shape of sigmoid s, so that means if you plot, if you plot this, let us say, in the, in the x axis I am measuring the bid amount, price, or bid amount. And y axis we are measuring actually that probability that Ri equals to 1.

This is let us say the highest one that probability Pi equals to this is 1. So, then your logit function will look like this. So that means this is 0, let us say 0, this is, let us say 50, then 100, then 150, 200, 250, like this. So that means from here what I can understand that as the bid amount increases, probability of saying yes is also decreasing, probability of yes is also decreasing. This is the logit function. This is the logit function or CDF of a logistic distribution, you can say.

Now the willingness to pay, what we are talking about, it is basically it has some connection with the, with the consumer surplus from the compensated demand, compensated demand function or demand function we have discussed in our microeconomics. So, generally the willingness to pay is the area under this logit model. And and the mean willingness to pay is actually the expected value, expected value of willingness to pay or mean willingness to pay ranges from minus infinity to plus infinity.

Because this is, this is nothing but a cumulative logistic function, so the range of that function is minus infinity to plus infinity. And we need to, we need to have a mean willingness to pay which may also, which may also vary from minus infinity to plus infinity. But you can understand that willingness to pay, negative willingness to pay does not make any sense. That is why, however, willingness to pay is non-negative.

That means what we need to estimate is expected value of willingness to pay, given that willingness to pay is actually greater than or equals to zero. So, I will repeat what I will say so this willingness to pay, what we are talking about expected value of willingness to pay, first we are deriving it purely from a statistical function. And the statistical function says that mean willingness to pay ranges from minus infinity to plus infinity, because that is the range of the distribution of this logistic function.

However, when we try to make a sense of this willingness to pay, willingness to pay negative, if it becomes negative that does not make any sense. We cannot make any sense out of this negative willingness to pay. That is why we need to calculate willingness to pay, it is called conditional willingness to pay or conditional mean, conditional mean, WTP, conditional mean, WTP.

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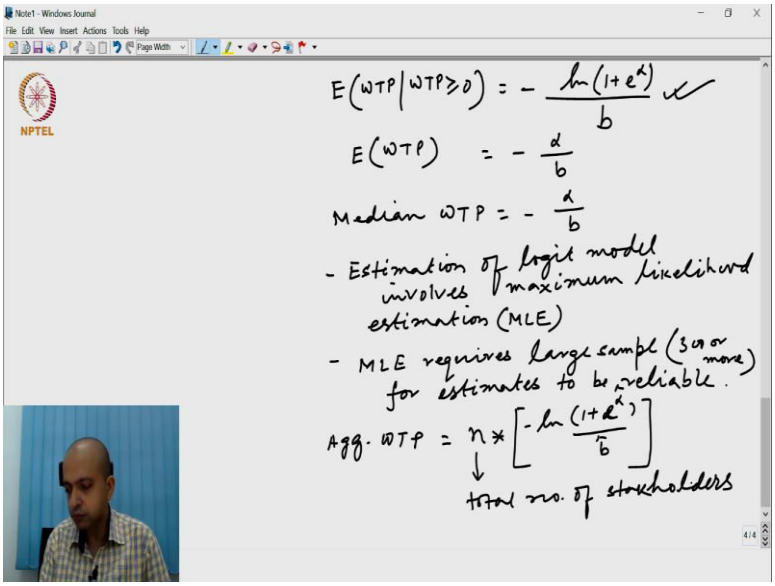

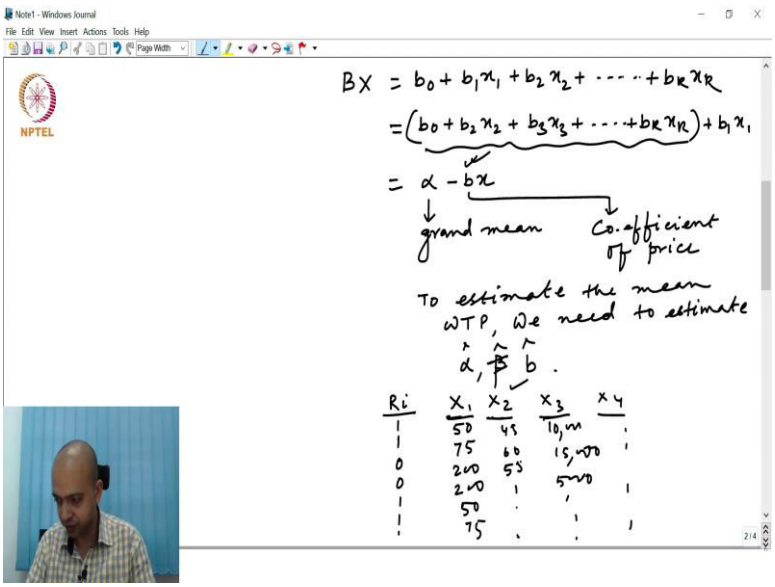

And that is expectation of WTP, given WTP is greater than equals to 0, equals to basically log of, we have one negative sign, then log of 1 plus e to the power alpha and divided by b. This b is actually the b which we have discussed earlier. This b is, this b we are talking about that means coefficient of price. So, this is the conditional b.

And if you simply estimate expectation unconditional mean that is nothing but minus alpha by e. This alpha is basically the grand mean, what we have estimated earlier. So that means to estimate and median WTP, if you take the median WTP is also equals to minus alpha by b. So that means to estimate the mean WTP, median WTP or the unconditional mean, what we need to get is alpha hat and beta hat.

How will you get alpha hat and beta hat? From that logistic regression. That means we need to collect the information about whether the individual is saying yes or no, for a particular bid amount, and then all other household specific feature we need to apply the logistic regression technique and then we will get this alpha and beta, alpha hat and beta hat by this logit model.

Now one thing we have to keep in mind, estimation of logit model that you can get it from my econometric lecture of logit model also, estimation, estimation of logit model involves, involves maximum likelihood, maximum likelihood estimation or in short MLE. And MLE requires large sample 300 or more, for estimates to be reliable.

So that means whenever we are interested to conduct this type of willingness to pay kind of study, one thing we have to keep in mind, we cannot simply collect some 50, 60 or 100 household's data. Because we can not rely the estimates of alpha hat and beta hat, derived from such a small sample. So, we need to have minimum 300 or more than that number of household's data, for getting reliable estimates of alpha hat and beta hat.

So, once we estimate the model from the big sample, we can easily calculate the conditional mean from this model, which is log of e to the power alpha divided by b. And then aggregate. How will you get aggregate WTP? Equals to as I say you have to multiply that with total number of observation. This with minus of log 1 plus e to the power alpha divided by beta. So, once we get this, this would become hat. So, n is the total number of stakeholders.