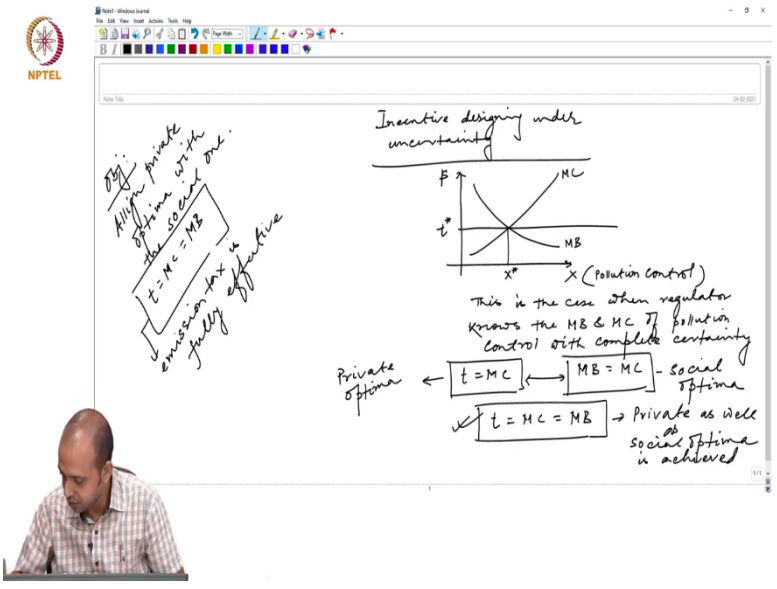
Environmental and Resource Economics
Professor Sabuj Kumar Mandal
Department of Humanities and Social Sciences
Indian Institute of Technology, Madras
Lecture 25
Incentive Design Under Uncertainty and Effectiveness Part 1

So, welcome once again to our discussion on incentive design. Yesterday in our last class we are discussing about incentive design, particularly the emission tax, how emission tax can help internalize the externalities that is what we have discussed. At the end we said that, however, even though theoretically it is possible to show that emission tax can actually help the polluting firms to internalize their externalities and emission tax can help actually bringing the pollution at the socially optimal level.

In reality, there is some kind of difficulty in the designing and implementing the emission tax. Rather, if life we said that, if life was so, simple, then society would have solved all its environmental problem. And then we said that, why there is a problem in implementing emission tax because the world is full of uncertainty. That means, at the theoretical level the emission tax is designed by equating marginal benefit and marginal cost of pollution control.

However, the regulator is uncertain about the true cost of pollution control, if that is the case, when there is uncertainty prevails around the marginal cost of pollution control, then how does a regulator will design incentives and emission tax that is what we are going to discuss today. So, that means, this is incentive design under uncertainty.

(Refer Slide Time: 02:07)



So, when there is no uncertainty then how the regulator decides, let us say this, this is x, which is pollution control level of pollution control in the y axis we are measuring dollar that means marginal benefit marginal cost everything you can measure. This is marginal benefit of pollution control, this is marginal cost of pollution control and the intersection between marginal cost and benefit that that is used to decide about the optimum tax rate t star and this is basically the x star is the optimum level of pollution control.

So, this is pollution control. So, this is the case when a regulator knows the MB and MC of pollution control with complete certainty. And in this case, the form the polluting form will equate t equals to MC to decide about private optima. This is called private optima and MB equals to MC this is social optima.

And if I equate this to t equals to MC equals to MB, so, that means, this is the point where private as well as social optima is achieved. Now, you have to keep one thing in mind that we require only this condition to happen t equals to MC equals to MB, because if you recall the entire purpose of incentive design is to align private objective with the social one.

So, that means, the objective of incentive design is to align private optima with the social one. So, when t equals to MC equals to MB that means, when this is achieved, we say that emission tax is fully effective. Emission taxes fully effective because the effectiveness of an instrument is designed by the success of it.

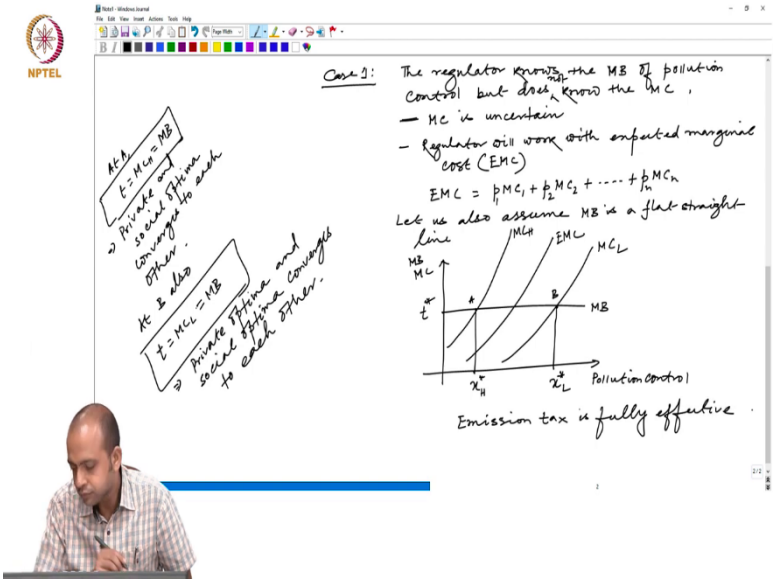
So, when the instrument is able to fulfil its objective, then we say the instrument is effective. For example, when I am taking a medicine to cure a disease and if the disease is cured, then I will say that the medicine is effective, it is effective to cure my disease. Similarly, we will say that emission tax is effective when emission tax is able to align private optima with the social one and that is possible when there is no uncertainty about the marginal benefit and marginal cost.

But, if the regulator does not know about the MC or MB of pollution control with complete certainty, then the question is whether emission tax will be effective that means, indirectly we can say that whether private optima will be aligned with social optima, if it is not that means, if there is a divergence between the private optima and the social one.

If there is a divergence then we will say that emission tax is actually not fully effective and ineffectiveness of the emission tax would be defined or measured by the divergence between

the private optima and social optima very simple. When these two things are equal, private optima converges with social optima, then we will say that emission tax is completely effective, fully effective, when there is a divergence between private optima and social optima, we say that emission tax is not fully effective, and the degree of ineffectiveness is measured by the divergence between private optima and social optima. That is what I wanted to say. Now, we will discuss about the cases alternative cases under uncertainty.

(Refer Slide Time: 09:02)



So, this is case one and in case one the regulator knows the marginal benefit of pollution control MB of pollution control. But, does not know the MC which implies MC is uncertain. Now, when MC is uncertain how the regulator will decide about optimal tax rate. Now, in economics probably in your Principles of Economics or micro economics, you might have studied decision under uncertainty when something is uncertain what the regulator will do or anyone will do the is to work with the expected one.

So, that means, when MC is uncertain, the regulator will work with expected marginal cost or EMC and how is this EMC defined? This EMC is basically equals to the probability, let us say this is probability into MC1 plus probability with MC2 plus pn MCn expected marginal cost. So, that means in an industry if there are n number of firms then the regulator is deciding is thinking maybe 25 percent of the firm is having marginal cost of like this MC1 another 25 percent maybe MC2.

So, some kind of rough approximation is calculated by the regulator and then the regulator is calculating expected marginal cost and this is how it is calculated. Probability how the probability is defined it is it is basically a fraction a ratio out of total 100 firms how many firms are having MC like MC1 this is some kind of rough approximation or the regulator calculates about the expected marginal cost.

Let us also assume MB is a flat straight line. So, that means this is the case. So, in the x axis we are measuring as I said pollution control and in the y axis we are measuring MB and MC. So, this is the MB which is known as a flat straight line. So, that means even if pollution control level of pollution control changes, every additional unit of pollution control gives all the same level of satisfaction that is the assumption let us not questioning about this assumption that is one of the cases and this is expected marginal cost since the original marginal cost is unknown, the regulator is working with the expected marginal cost and how the t star would be defined.

It is the intersection between MB and MC since MB MC is unknown intersection between MB and EMC will give you the tax rate, optimal tax rate t star. And now assume that original or actual marginal cost is actually higher than the expected one. So, this is MC, let us say higher than the expected one. Then we will see the effectiveness of tax rate. First, we will decide about the private optima.

What is the private optima? How it is decided. t equals to MC. Now, you see where is the T equals MC, this is the point, where is the social optima MB equals to MC where it is achieved? Here. So, that means, this is the point optimum level of pollution control and at this point both private optima and social optima is achieved, let us say that this is point A. So, that means at A, t equals to MC equals to MB is achieved.

So, even when the actual marginal cost is higher than what you expected, since the marginal benefit curve is flat straight line, we still have private optima converges to social optima. So, that means emission tax is fully effective. So, that means, this implies private and social optima, social optima converges to each other. Now, let us say that actual marginal cost is lowered, this is MC low then what is happening?

Let us say this is point B. So, t equals to MC is achieved yes t equals to MC this is the t, tax rate MB equals to MC is also achieved. So, this is let us say x star low. So, that means,

pollution control when the marginal cost is lower than MC and even in this case also at B also what we can see that t equals to MC rather I will say this is MCL and this is MCH equals to MB is still achieved.

So, that means private optima social optima converges to each other. So, that means in this case when marginal benefit curve is flat straight line then emission tax is fully effective even though the regulator does not know the true marginal cost of pollution control, that is the beauty of this mechanism given that marginal benefit is flat straight line. In both the cases in point A as well as in point B social optima converges to private optima. Emission tax is fully effective. So, what I again say that emission tax is fully effective. This is case one