Environmental and Resource Economics
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Lecture 24
Coase Theorem and Incentive Design Part – 3

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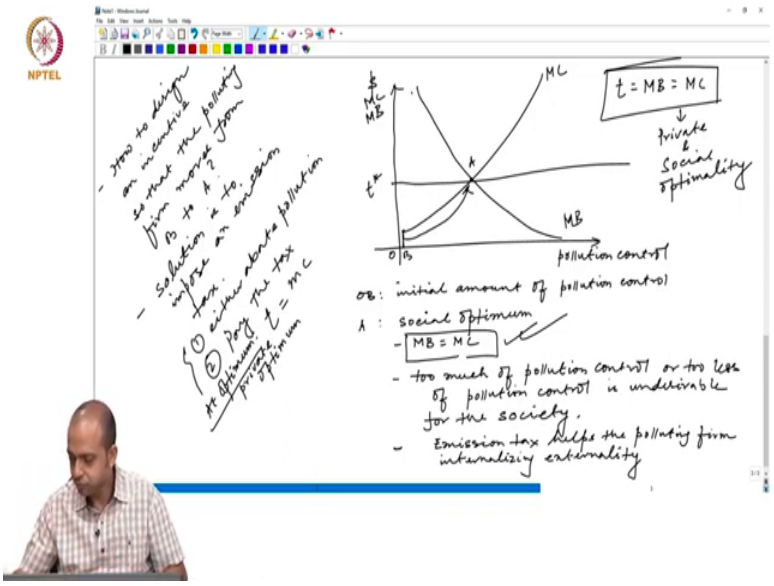

How does it happen? We will understand with a simple diagram. let us say that in the x axis, we are measuring pollution control and in the y axis, we are measuring money or dollar. What is the advantage because you can measure cost, benefit, everything, you can measure cost or let us say I am saying marginal cost, marginal benefit, everything you can measure it in monetary terms, that is why in the y axis we are measuring dollar or rupees, whatever.

Let us say that marginal cost is upward sloping, marginal cost of pollution control. Why this is upward sloping? Because for every unit of pollution control, additional pollution control becomes costlier than the earlier. Why this is so? Because if you clean the environment too much, that means, further cleaning the environment becomes difficult.

I already told you in previous context that when the environment is already very clean, cleaning it further requires more advanced technology. That is why marginal cost of pollution control is

upward sloping. Similarly, the marginal benefit, let us say this is marginal benefit of pollution control, that is downward sloping. Why this is so?

Because every unit of pollution control gives lower and lower additional benefit. Initially, when there is very less pollution control, when the environment is so dirty, if it is clean by one unit, then the society would get huge benefit. Likewise, if you keep on increasing your pollution control, every additional unit will give you lower, lower and lower benefit. That is why marginal benefit of pollution control is downward sloping.

Now, when there is no incentive given a private player will try to set the level of pollution control at a level where the cost is very minimum. So, that means probably a private player will try to send the pollution control at this level later that is point B. Why this is so? Because at this level the marginal cost of pollution control is very less.

So, private player will control only if this is O, let us say OB amount. So, OB is the initial amount of pollution control. If the MC curve starts from the origin, they can choose to select zero amount of pollution control as well. So, this can start from the origin also, when there is zero pollution control, then there is zero cost and, in that case, it will choose at a zero level.

For simplicity's sake, we are drawing our MC curve in this way. That means, we are saying that when there is zero pollution control, then also there is some kind of cost involved. Why this is so? Because of the initial fixed cost amount, we may think about. Now, the society wants pollution control at this level, that is point A, so society wants A is actually the social optimum.

Why this is so? Because at this level marginal benefit of pollution control is equals to marginal cost of pollution control. Please keep in mind, this is the social optimum. Society wants pollution control at a level where marginal benefit of pollution control and marginal cost of pollution control is equal.

Society does not want too much of pollution control or too less of pollution control that also we have to keep in mind. Too much of pollution control or too less of pollution control is undesirable for the society. Why? Too less of pollution control we can understand that is not

desirable for the society, but why too much of pollution control is also not desirable? Can you think of why too much of pollution control is also equally bad?

Because pollution control means the firms are paying, are spending money for this activity, that when the cost of production for the firms will increase and the firms will try to bypass some of this cost on the consumers in the firm of higher price, do you think that the business entities, they will incur the entire cost of pollution control? No.

The moment cost of pollution control increases entire cost of production will increase and the firms will try to bypass some of this cost on the consumers in the form of higher price. How much they would be able to do so that again depends on elasticity of demand. If the consumers are highly elastic, then the firms would be able to bypass very less amount of cost. If the consumers are less elastic, then what will happen, the firms will bypass more amount of this cost.

So, that means, society does not want the goods to be, the cost of production to increase too much, because that is also bad. Consumers they have to pay more. So, society wants only optimum level of pollution control or pollution and how is it determined MB equals to MC at a point.

Now, the question is how to move from point B to point A. That means, what type of incentive to design so that the firm can move from point B to point A. That is the question. How to design an incentive so that the polluting firm moves from B to A. Now, the idea is simple. When the firm is operating at B at a very lower level of pollution control that means the firm is thinking, avoiding pollution control is very cheap, that means there is no cost the firm is paying for not controlling the pollution.

In absence of any incentive the firm is thinking that even if I do not go for pollution control, even if I simply throw my garbage to the environment, I do not have to pay anything. So, incentive has to be given in such a way that this cost of environmental shirking as I told you earlier increases.

Let us now assume, the solution is to impose a tax, emission tax. When tax is imposed, then the firm has two options. What are those? Either abate pollution or pay the tax. The firm can either

abate pollution or pay the tax. And how the firm will decide? Out of these two options which one to select?

As long as marginal cost of abatement is higher than the tax rate. Obviously, the firm will go for paying the tax, if the marginal cost of abatement is higher than the tax amount, so it is beneficial for the firm to pay the tax. And when tax is higher than the marginal cost of abatement, then the firm will go for pollution abatement.

So, that means, at optimality the tax rate actually should be equals to, at optimality this tax should be equals to marginal cost of abatement and this is a private optimum. So, private player will decide how much to evade depending on the tax rate and marginal cost of abatement.

So, private player will equate these two to decide about the private optimum level of pollution control. So, this is called private optimum, we have already got another optimum which is called social optimum, this is called private optimum. Now, if I combine these two, I will get a condition which is called t equals to MB equals to MC, where the private and social both optimum are satisfied.

So, that means the policymakers or the government should decide the tax rate at a point where t equals two MB equals to MC is achieved, this is called optimum tax rate. At this point, t equals to MB equals to MC is achieved. So, private optima and social optima is converging. So, that tax rate actually motivating the firm to move from point B to point A.

So, private optima which was earlier at B, there was no cost of avoiding pollution has now moved to this point A, because now incentive is given in the form of this tax. If you do not abate you need to pay the tax. If you abate you can save some amount of money by not providing the tax. So, private player will equate equals to MC here and MB equals to MC is achieved here.

So, society will, social planner or policymaker will decide the optimum tax rate by this condition MB equals to MC. And private player is t equals to MC, if you combine these two this is called at this point private and social optimum. So, this is called private and social optimality.

So, that means, one thing we can say these emission tax actually helps the polluting firm internalizing externality. This is a very important statement I am making; I will write the

statement then we will explain. Emission tax helps the polluting firm internalizing externality. What is the meaning of internalizing externality?

Before imposition of tax the firm was not thinking anything about the externality that means, the firm was not thinking about the cost of this pollution to the society. Firm was only concentrating on its own profit. So, in that profit making process, when the firm was deciding about how much output to produce, to maximize profit, there was no consideration about the social cost of this pollution, about the social damage caused, the damage the pollution makes to the society was not at all considered by this profit-making private business firm.

The moment the tax is imposed, the firm is now thinking about the cost to the society also. And that helps that means firm is now considering the externality into her business making process. The firm is now thinking the cost it imposes to the society while deciding about optimum amount of output.

That is why I said that emission tax helps the polluting firm internalizing externality. Now, this can be understood more clearly by a simple mathematical model.

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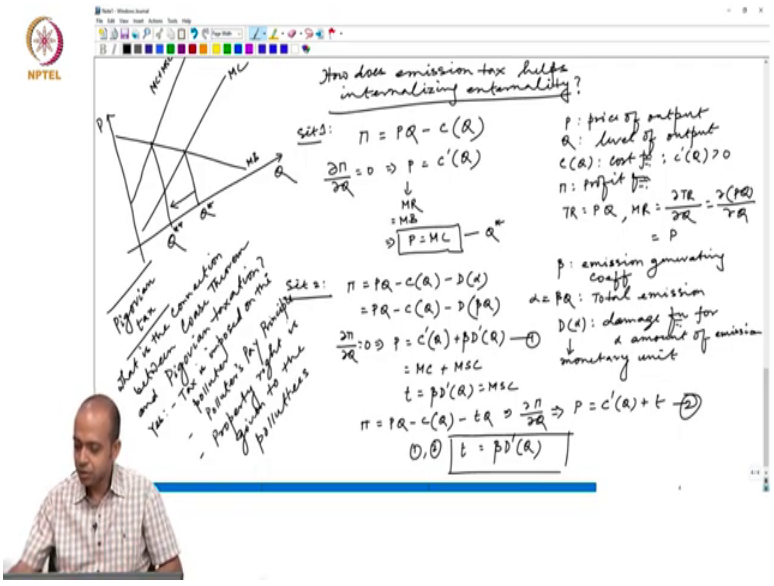

So, the point what we are discussing, how does emission tax helps internalizing externality? Let us assume pi is actually the profit function of a firm. So, here P is price of output, Q is level of

output, C function Q is actually cost function, where C prime Q is greater than 0 and pi is actually the profit function.

Now, how does the firm decide about the optimum level of output? Simply differentiating this profit function with respect to output and set it equals to 0 and that would imply P equals to C prime Q. And what is this P? P is actually you can think of MR, because when you are differentiating P Q, P Q is actually total revenue. So, I can say that TR equals to P into Q and M R equals to delta TR delta Q that means delta PQ delta Q, which is actually P, and this is I can also known, can be termed as marginal benefit.

So, P equals to MC that means, what I can say that P equals to MC is the condition by which the firm is deciding about the optimum level of output. Let us say that in a two-dimensional figure, let us say this is demand, this is supply. So, this is let us say Q star, this is M B, this is M C, M B is downward sloping demand curve is also known as marginal benefit curve. So, this is the optimality. How is the optimality decided? By this process.

Look at here, this is purely determined based on only the total revenue and total cost and this cost C function C(Q) is only a function of output that means, this is only the private cost of production, firm is not thinking anything about the cost of pollution to the society. Let us now assume further that beta is the emission generating coefficient.

That means, for every unit of output beta amount of emission is generated. So, betaQ is total emission and there is some kind of cost to the society, let us say this is equals to alpha and we also assume that d(alpha) is the damage function, damage function for alpha amount of pollution or emission, this is the damage function. So, that means, this is some kind of monetary value measured in monetary unit.

Now, if the firm now considers about the damage cost to the society due to its pollution, then this profit function will change. This is situation 1, and let us say this is situation 2, when the firm starts deciding about the damage cost to the society due to the pollution. And how the profit function will change?

P Q minus C Q minus D alpha cost to the society also has to be deducted from the total revenue. So, that means, this is P Q minus C Q minus D into this alpha is nothing but, so, again if you differentiate and set it equal to 0 del pi, del Q equals to 0 implies P equals to C prime Q plus beta D prime.

So, that means, profit maximization requires price should not only be equals to marginal cost rather this is marginal cost which is purely private cost of production plus marginal social cost, beta D prime is actually called marginal social cost for every unit of pollution what is the cost you are imposing to the society, more pollution means more mortality, morbidity, so on and so forth. Society will suffer from this pollution and if I can measure this kind of cost, how will you avoid mortality, morbidity, you have to go for treatment, there is some kind of treatment cost.

If I know exactly in monetary unit what is the cost then that is beta del D prime that is called marginal social cost, but the question is then, but the question is then what should be, how will you motivate this firm to think about this beta del prime. So, policymaker will impose a tax which will be equals to beta D prime equals to marginal social cost.

That means, if a tax is imposed per unit of output, then the profit function will change in this way P Q minus C Q minus t Q and if you differentiate with respect to output, then that will become P equals to C prime Q plus t . So, if you got let us say this is equation 1, and this is equation 2. So, from this you can very well understand that t should be equals to beta D prime Q.

So, tax should be imposed at a level at which t equals to beta D prime. When the tax is imposed, what will happen then? Then this marginal cost curve will shift upward because this is now become M C plus M S C. And production level will go down from Q star to Q double star. So, that means, when the firm was not internalizing the pollution or externality in absence of any taxation, the firm was over producing, the firm was over polluting, which is not socially desirable.

The moment tax is imposed, the firm starts internalizing the process and then the marginal cost curve shifts upward and then the pollution level goes down from Q star to Q double star. That is

the idea. Is this clear? So, this is how we can show that how emission tax can actually motivate the firm to internalize the externality.

And this taxation was first introduced by the British economist Pigou that is why this is called Pigouvian tax. Now, if I ask you to think about is there any connection between the Coase bargaining, Coase theorem and the Pigouvian tax what we discussed now. So, the question here I am asking what is the connection between Coase theorem that means the idea what Coase suggested that you assign property right and allow them to bargain and the idea what Pigou suggested and Pigouvian taxation is there any connection at all?

Coase said no intervention, you simply assign property rights and allow them to bargain or negotiate they are costless bargaining will result in efficient level of pollution which is Q double star, this is output actually. So, Q double star will correspond to that level of pollution. And Pigou said you impose some kind of tax.

Now, is there any connection between the earlier framework Coasian framework and the Pigouvian framework? The answer is yes, answer is yes. Why this is so? Because in Pigouvian taxation tax is imposed on the polluter. So, that means, this is polluters pay principle

So, that means, property right is given to whom? Property right is actually given to the pollutes, to you, to me, to so many other people in the society to enjoy clean air. Polluter the firm has no right to pollute. That is why the government is playing on behalf of all of us and asking the polluter to pay for its pollution.

So, that is why property right is given to the pollutes, pollutes means to you, to me, to so many other people who are suffering from the pollution. So, that is the connection between the Coasian bargaining and the polluter pays principle or Pigouvian tax. So, that means Pigouvian tax is not completely different from the Coase theorem. The idea is borrowed from the Coase theorem only.

The government is saying you do not have any property right to pollute, rather society has the right to enjoy clean environment. And if you need to produce or pollute, you rather pay some tax

or compensate that the pollutes for their suffering. The tax then collected would be used for the cleaning purpose that is the idea.

So, this is the mechanism, this is how polluters pay principle and emission tax work. But one thing we have to keep in mind, if life was so simple, then society would have cleaned all its pollution, we would not have any issue, any problem with the pollution. But in reality, what we see that there is a lot of pollution. So, that means society is not able to decide about the optimum pollution Why is it not happening? What is the problem with this Pigouvian tax?

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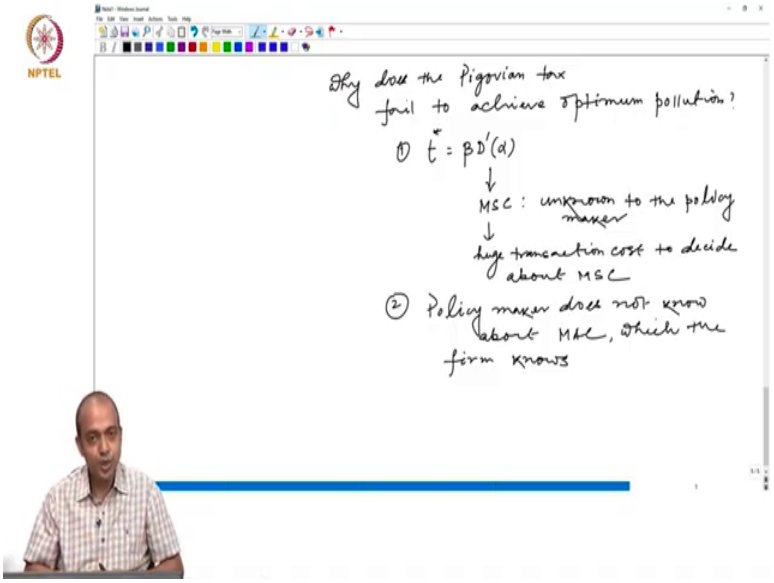

So, the question is then, why does the Pigouvian tax fail to achieve optimum pollution? Because, see, the entire idea is based on t equals to beta D prime alpha which is basically marginal social cost. Now, this marginal social cost or the damage is unknown to the policymaker.

I do not know exactly what is the cost because assigning a monetary value for this pollution is extremely difficult. Pollution also travels from one place to another, it may not affect your health immediately, it may affect your health after 5 years, 10 years down the line. So, that means one thing pollution travels from one place to another.

So, that means, it affects the health condition of the people who are residing at the source where the pollution is generated as well as people who are residing away from that. Sometimes it

affects immediately, sometimes it does not, if that is the case, what exactly is the marginal social cost of this pollution that is unknown to the policymaker.

And if that is unknown, how will you decide about this tax rate? And if you cannot decide about this optimal tax rate, obviously, you cannot get optimum level of pollution. So, there is huge amount of transaction cost to decide about MSC. That means, there is complete uncertainty about this social cost.

Similarly, this is number 1, number 2, policymaker does not know about marginal abatement cost also which the firm knows. So, that means the policymaker has to work in a world which is uncertain, neither the social cost nor the cost of pollution control is known with accuracy. If that is the case, then incentive designing has to be worked considering this type of uncertainty.

That is why in our next session we will discuss about how to decide about this emission tax when there is uncertainty about the marginal cost of abatement or marginal abatement cost MSC. With this we are closing our discussion today and in our next session we will talk about imposition about emission tax in case of uncertainty. We will examine how effective that emission tax would be if we assume this type of uncertainty in our model. Thank you.