Environmental & Resource Economics
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Lecture 18
Market Failure and Coase Theorem Part - 1

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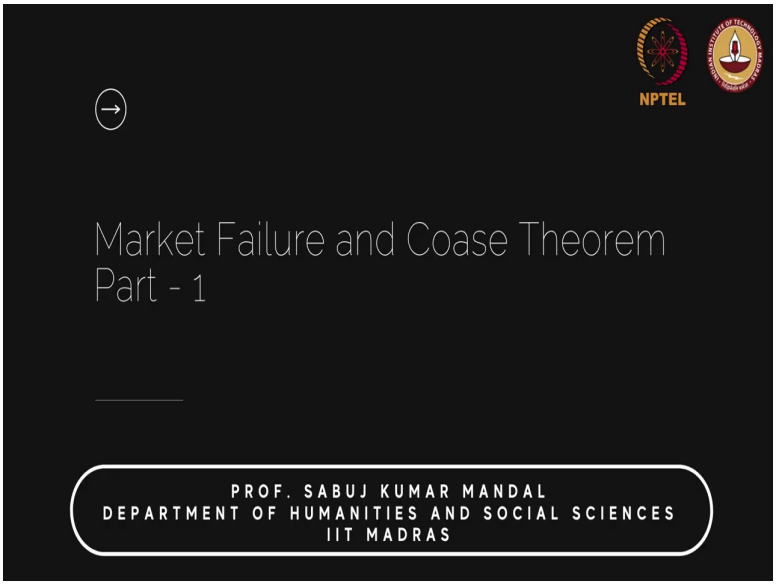

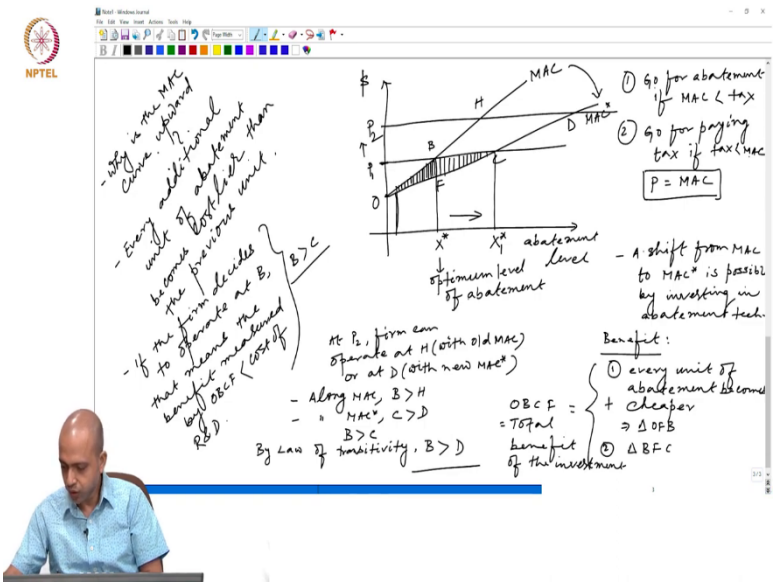

So, in Palmer Oates and Portney's framework, they have drawn a simple diagram. In the X axis they measured abatement level, and in the Y axis, they have simply measured dollar or rupees or whatever. What is the advantage of measuring everything, putting dollar in the Y axis? Because you can measure the cost of abatement, benefit of abatement, everything.

Because everything has to be measured in monetary units that is why we are measuring only dollar in the Y axis or you can put rupees on the Y axis.

Let us say that the initial, this is called marginal abatement cost curve, the question that I am asking? Why is the MAC curve upward sloping?

Can you think of why is this MAC curve upward sloping? So, that means, for every additional unit of abetment your marginal cost of abatement is actually going up and up. So, every additional unit of abatement becoming costlier than the previous unit. What is the logic? Can you think of, why the MAC curve is upward sloping? Why every additional unit of abatement becomes more costlier than the previous one?

Now, to answer this question, you can apply one simple logic that when, at the initial level when abatement level is very low, that means, there is too much of emission. When emission level is too much, then it is very easy to clear the emission. As you keep on abating the pollution level or emission level will come down, and it would be very hard to clear the environment even farther when it is already cleaned.

Suppose, I am asking you to clean this room, which is full of dirts. So, initially it would be very easy for you to clean a unit of dirt when it is already very dirty. But if you keep on cleaning this room at one point of time the room would be so cleaned that it would be very painful for you to clean that room even further. That means, the simple technology cannot clean a room, which is already cleaned. So, that means you cannot clean a room when it is already cleaned by simply the simple jhadus, probably you have to bring in the high power machine like Daison and all, which is used, the vacum cleaner which is used to clean our room.

So, that means, when emission level is very high, cost of cleaning is low. When emission level is very low cost of cleaning would be very high. Based on that logic, we say that MAC curve is upward sloping. As you keep on abating, pollution will come down and every additional unit of abatement becomes costlier. That is the reason the MAC is upward sloping. The answer is every additional unit of abetment becomes costlier than the previous unit, that is the logic.

Now suppose the effluent charge is P1. The policymakers set an effluent charge which is P1. Now, at this P1 emission charge what should be the equilibrium level of abatement? Can you

think of, this is the emission level, sorry, this is the emission charge, that means, emission tax or affluent charge, whatever you may think of that is P1.

How the firm will decide how much to abate? Now, we have to keep one thing in mind, once tax is imposed or any effluent charges imposed firm they have two options. What are those option number 1, they go for abatement, if MAC marginal abatement cost is actually lower than the charge or tax. And secondly, go for paying tax if tax is lower than MAC. That is very simple.

So, the firm can either pay the tax or go for abatement. What they will do? They will first see for one unit of abatement what is the cost and what is the tax rate? So as long as the tax rate is higher than marginal abatement cost, obviously, it is beneficial for the firm to go for abatement than paying the tax. So, that means, optimality is achieved when this P is actually equals to the MAC.

So, that gives optimum level of abatement. So that means you have to simply equate this. Simply create this and your, this is let us say X star is the optimum level of abatement by equating P equals to MC. Let us say that this is point number B. They have simply equated the tax with the marginal abatement cost and decided about optimum level of abatement. So, this is called optimum level of abatement.

Now, suppose firm can invest more in this MAC technology, that means, abatement technology so that per unit cost of abatement goes down. So, that means, if the firm invest in R&D to come up with better technologies, this MAC will shift from let us say MAC to MAC star. That is possible. So, a shift from MAC to MAC star is possible by investing in abatement technology.

Now whether the firm will invest in the technology or not, that depends on, what is the benefit of that and what is the cost of that. Let us first give different name. So, let us say that this is C, let us say this is O, let us say this is F. So, let us now think about What is the benefit? Benefit of investing my money into that R&D so that MAC shifts from MAC to MAC star.

Now, when MAC shifts from MAC to MAC star there are two benefits. Firstly, what will happen, the benefit number 1, every unit of abatement becomes cheaper. See, earlier, for this

unit of abutment the cost was this much, but now, this is only this much, so, that means, there is some kind of saving.

So, for each and every unit that means there is some kind of saving. Since, abatement becomes cheaper, the firm can actually save some money for every additional unit of abatement. If you add all this benefit then this OFB this equals to the triangle OFB, that is the first component of the benefit, which is generated because every additional unit of abatement becomes cheaper.

And what is the second one? Second benefit is that with the new MAC curve you can actually await more amount of pollution. If the pollution charge is fixed at P1 instead of B now you can go up to C. So, that means, you can go from X star to X1 star, and that will give you anotherbenefit. So, that means, this is actually the triangle BFC.

So, this plus this, if you add, then that is actually equals to OBCF is actually total benefit of the investment. So, if the firm invest money in R&D to come up with better technology, so that MAC shifts from MAC to MAC star, there are two types of benefits the firm will enjoy. Firstly, OBF the triangle. Why it is generated? Because every additional unit of abatement becomes cheaper.

Secondly, when it is cheaper, given the tax rate P1, firm can actually go for higher level of pollution abatement. Initially, they were abating up to X star, now, they will go from X star to X1 star because tax is equals to MAC happening this condition P equals to MAC is happening only at point C. So, this is the total benefit.

Now, if the firm is operating at point B, that means, what we can say that cost of such investment, cost of innovation is actually higher than the benefit measured by this area OBCF. So, that means, what we can say that if the firm decides to operate at B, that means, the benefit measured by OBCF is actually less than cost of R&D, that is what we can say.

So, this is the pre-regulation scenario. There was no regulation. That means, regulation was there, I mean, regulation was modest amount, it was not so stringent, only P1 amount of tax is imposed.

Now, according to Porter we need to analyze, if the tax rate increases from P1 to P2. Let us say this is P2. What will happen? Whether the increase in tax rate from P1 to P2 can motivate

the firm to go for innovation. At P1 level we have just established that the firm decides to operate at B because the benefit amount is lower than the cost of R&D.

So, at P2, firm has actually two option, either to stick to the old technology and operate at H, or to go for innovation and operate at D. Now, what we have to show that neither H nor D is actually better than B. How to show that? Please try to understand. I will repeat once again what I am saying.

Previously, when the tax rate was P1, set at a very moderate level that was not enough to motivate the firm to go for R&D, that means, the technological innovation, which could possibly shift the MAC from MAC to MAC star because the benefit amount measured by OBCF is less than the cost of such R&D.

Now, according to Michael Porter, stringent regulation may induce the firms to go for innovation, and that is what we are doing. We are increasing the tax rate or effluent charge from P1 to P2 and we will examine whether at P2 level of emission tax or effluent charge, the firm can actually go for the innovation or not. So, what is happening at P2? At P2, firm can operate at H with old MAC or at D with new MAC, which is MAC star by technological innovation.

We have to show, that neither H nor D is actually better than B. How will you show that? Let us first think about the old MAC. Now along the old MAC, it is very straightforward to show that profit at B is greater than profit at H. Because the firm is facing the old MAC curve affluent charge has increased. So, the firm is actually abating more with the old technology. So, what will happen? Obviously, profit at H would be lower than B.

So, that means, what we can say, along MAC, we can show that B is actually greater than H. B is greater, very straightforward. My technology is old, and the new effluent charge is asking me to abate more so, obviously, profit will go down, so B is greater than H. But, H and D is not directly comparable.

H and D is actually not directly comparable, because at H you are facing the old technology and new tax rate. At D, you are facing actually the new technology with the new tax rate. So, since H and D are not directly comparable, what we will do, we will think about along MAC

star what is happening. Along MAC star, if we compare C and D, then again it is very straightforward to see that profit at C is actually greater than D.

Because following the same logic, at D the firm is actually going for higher abatement, and tax rate is higher. So, C is greater than D, very straightforward. And we have already established that B is greater than C. So, from these actually, from these when the firm decided earlier to operate at B, that means, B is greater than C, that we have already established. Firm was not interested earlier to go for innovation because B is greater than C. So, that means, earlier we establish B is greater than C.

Now, if you apply law of transitivity, we can show that B is actually greater than D. B is greater than C, C is again greater than D. So, what I can say that B is actually greater than D. Now, even though the framework is very simple, it is highly powerful. Why this is powerful? Because with this simple model Palmer, Oates and Portney, they could actually establish that if innovation was not profitable with the modest amount of regulation, it is still not profitable even after making the regulation so stringent.

What Michael Porter said, that if you make the regulation more stringent then that will lead to more innovation that is actually not true. It is a simple diagram they have nicely explained. This is the framework, so that means, the cost component what was completely missing in Porter's argument, while judging evaluating regulation they have introduced.

If you impose regulation, more regulation from P1 to P2, what is the cost of it and what is the benefit of it? So, benefit is basically when the MAC shifts for MAC to MAC star, this is the benefit OBCF. And what is the cost? Cost they have also analyzed. So, when you introduce cost and analyze the situation in a benefit cost framework then you can actually show B is greater than D. So, that means if innovation was not profitable, with a modest amount of affluent or emission tax P1, it is still not profitable, even when with a increased effluent tax P2. That is what they said. Of course, there are certain limitation in Palmer Oates and Portney’s framework also.

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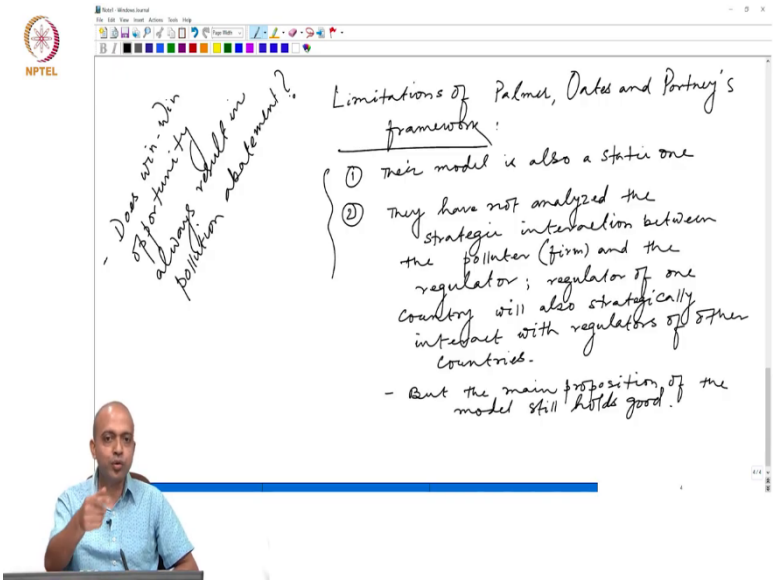

What are the limitations? The the limitation of Palmer Oates and Portney's framework. Firstly, their model is also a static one. Why this is a static one? Because they have not analyzed the strategic interaction between the polluter, and here, it is the firm and the regulator.

So, over time, there would be some kind of strategic interaction. The moment I impose tax, the firm will strategically behave. Strategically decide about their level of pollution. Then in next time, the regulator will also decides about the level of emission tax. So, that means, in a repeated time framework, that means, in a game theoretic framework multiple sort game in a dynamic game actually it is possible to analyze such kind of strategic interaction between the polluter and the regulator, and also strategic interaction between regulator of one country with the regulator of another country.

Once the regulator impose regulation in India, how the regulators in China, Pakistan, US and other countries will behave? Also, regulator of one country will also strategically interact with regulators of other countries. So, these are the main two limitations. But even if you make the system dynamic, the main proposition of this model, what they said, that if innovation was not profitable with the modest regulation it is still not profitable with the stringent regulation that still holds good. But the main proposition of the model still holds good, even if you make system dynamic.

So, that means what we have discussed so far. First, we discussed about Porter's argument, then we discussed about Palmer, Oates and Portney's argument to challenge Porter's this

thing. But interestingly, because of this huge importance of this Porter hypothesis on policymaking, even today people are trying to, empirical researchers they are trying to find out whether Porter's hypothesis is actually true or not using empirical data.

And not only that, there are researchers they are asking additional question. What Porter said, that regulation will create a win-win opportunity. But if we ask, does win-win opportunity always result in pollution abatement? That means, so far, economists or empirical researchers, they are asking this question, whether Porter's hypothesis is true or not, with empirical data.

So, that means, whether regulation is leading to higher level of output and lower pollution or not. But if we ask this question, even if such win-win opportunity exists, whether such opportunity will always result in pollution abatement or not? And I have one paper, exactly on this title, where I actually examined this particular question. And I saw that even if there is win-win opportunity resulted from the regulation, there is no guarantee the firm will always go for pollution abatement.

Rather, what the firm may try to do, they will try to bypass the regulation with some illegal negotiation with the pollution control authorities. Many a times what we see that these polluting firms and these regulating authorities they have some illegal negotiation, Pollution Control Board, they are sending some officials to examine whether the regulation is properly implemented, but what happens in reality, these polluting firms, they bribe these officials, that means, there is a possibility of illegal negotiation.

And because of this illegal negotiation even if such win-win opportunity exists, they may not get result in pollution abatement. So, we have one paper, that paper we will discuss in a later context, wherein, we will be discussing how to measure environmental efficiency of the firms. So, that means, how to measure cost of abatement, cost of regulation. We have already told that in Porter's argument, the cost part was missing.

Now, the framework what we have applied in our search, there is one clear advantage. It will help us understand, what is the cost of complying with the regulation. So, we showed that if such cost of compliance is higher, then that may not always lead to pollution abatement. Rather, firm will always try to bypass the regulation and produce even more output.

Of course, they will become efficient, but they will avoid the regulation. And how they will avoid by this illegal negotiation, that when there is some kind of transaction cost, of course. So, if the transaction cost is lower than what the benefit they enjoy, firms will always try to bypass the regulation and that we clearly demonstrated in our research that we will be discussing in a later part. Thank you.