Introduction to Environmental Economics
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Lecture - 56
Environmental Regulations and Basic Regulatory Instruments-Market Based Instruments/Approches – II

Hello everyone, we are continuing with the Environmental Regulations and Regulatory Instruments and we in the last lecture we discussed about the market based instrument that is the pollution tax or pollution fee.

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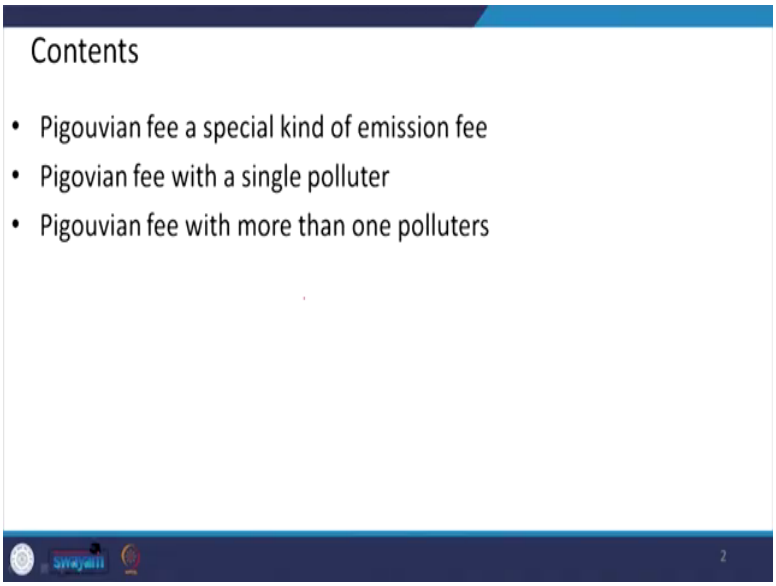

So, today we will be continuing the same one and we will be discussing what is the Pigovian fee that we discussed. And now we will be discussing how this Pigovian fee is a kind of special

emission fee or special pollution fee right, it is not a pollution fee as such, but it is a special category of pollution fee or emission fee that we will be discussing.

And then we will be discussing the Pigovian fee if a single polluting firm is there. So, how the Pigovian fee is decided and then we will be discussing in the presence of multiple polluters how this Pigovian fee is going to be determined right.

So, now let us talk about that how Pigovian fee is treated as a special pollution fee, not a pollution fee. So, as you understand that we have already discussed in Pigovian fee or Pigovian tax lecture that it is a kind of emission fee and this emission fee is determined at the marginal damage of the a pollution itself.

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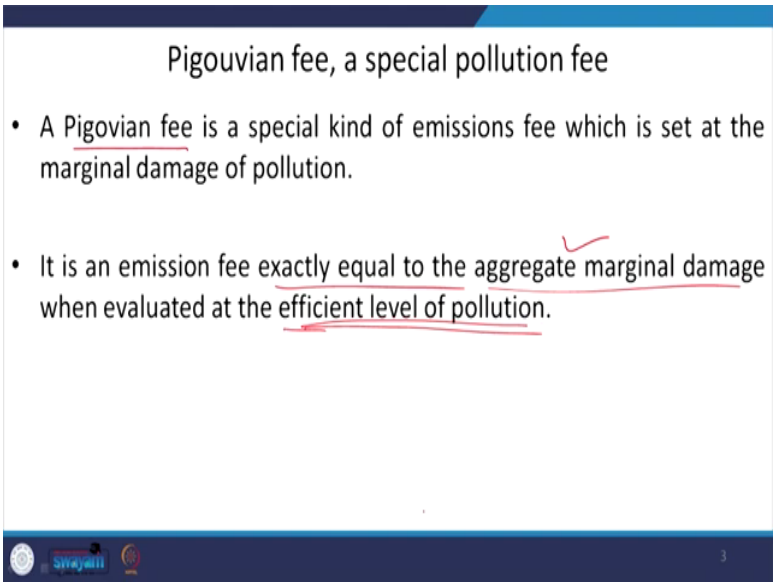

And moreover, this emission fee is exactly equal to the aggregate marginal damage and when it is evaluated at the efficient level of pollutions right; so that means, here we want to say that Pigovian fee is determined as per the aggregate marginal damage and this aggregate marginal damage is estimated based on the efficient limit level of pollution. So, this efficient level of pollution is also the optimal level of pollution.

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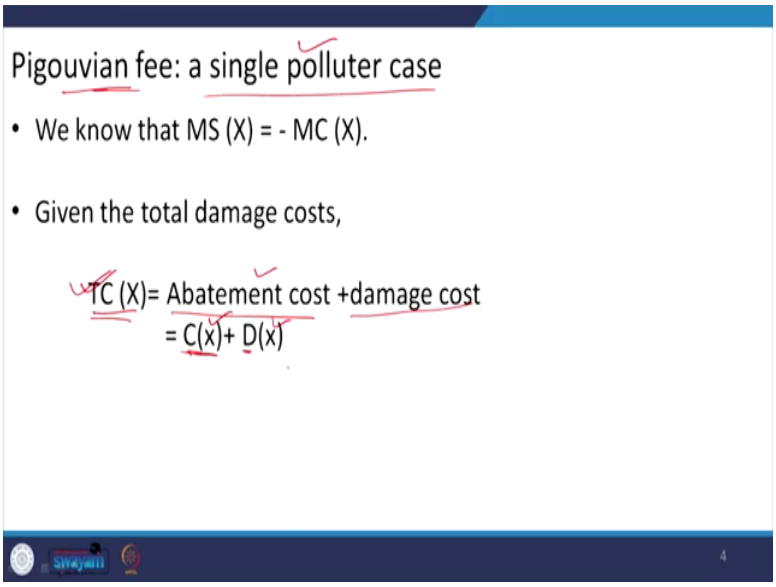

So, you can remember the optimal externality or how we are determining the optimal or efficient externalities. So, after understanding this just Pigovian fee the definition that we discussed earlier. So, now we will be discussing how this Pigovian fee is going to be determined, going to be saved if a under the case when a particular firm is a polluter.

So, here we are taking into account as if only one single firm is there who is polluting ok. So, from the previous class we already understood that this marginal saving function right from

pollution is equivalent to the negative of the marginal cost function of the pollutions right. And again we know that the total damage cost, given this total damage cost from the pollutions we can find this total cost.

So, what is the total cost? Total cost is the composition of these two terms the first one is the abatement cost that how the firm is going to spend and reduce the level of pollution and the second one is if the firm is not at all going to reduce it what is the damage cost it is taken into account right. So, we can say this total cost is equivalent to the abetment cost that is a function of the pollution level and also the damage cost that is also a function of pollution level.

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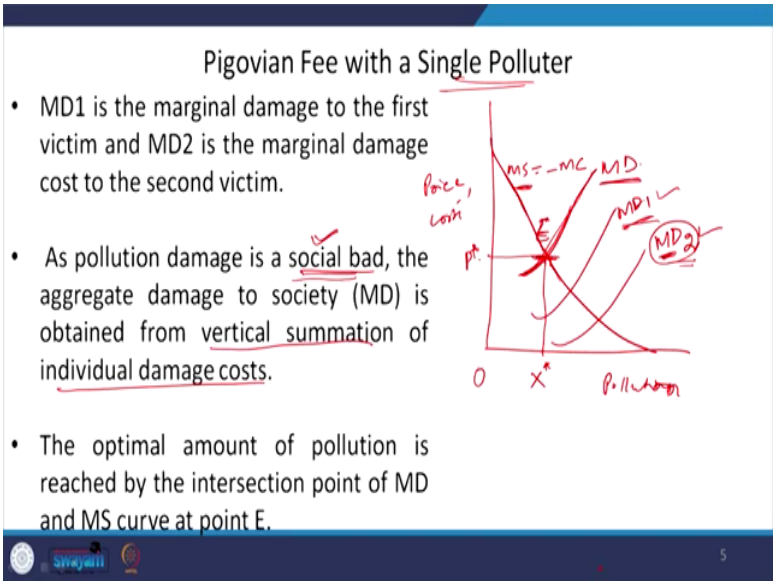

So, given these now we will be finding that how this; this Pigovian fee is determined when the pollution, when the polluter is a single entity right. So, we can graphically explain that first.

So, you can take in the horizontal axis; we are explaining the pollution itself pollution and in the vertical axis we are measuring the price and costs.

And we know the marginal saving function, what is the shape of this marginal saving function? It is negative and this marginal saving function is equivalent to what? The minus of marginal costs, we have already learnt that what is the marginal saving function and what are the features of marginal saving function, as well as the features of the marginal cost function right.

Now, you are saying that the single polluter is there right and as a result let us say that because of this pollution activity it is impacting and damaging let us say two persons; so that means, there are two victims of the a pollution right. So, you are saying that let us say this is the marginal damage function of the first victim and this is the marginal damage function of the second victim ok.

So, now you are saying that this MD 1 is the marginal damage to the first victim and this MD 2 that we have just drawn is the marginal damage cost to the second victim and as you understand this damage is; obviously, not a private good or private bad right. So, this damage is; obviously, not a good; it is a bad first thing and second one is it is not a private bad; it is a social bad or public gap public bad.

So, because this pollution damage is the nature for the nature and characteristics of goods and bads are concerned, it is not in the category of private good; rather it is a private it is a social good. So, take into account this the very nature that it is social or public we can say. So, the aggregate damage that is; that we are finding right from the action of the polluter, it can be obtained by the vertical summation of the individual damage cost.

So, if you have to find out what is the aggregate damage function that is borne by the first victim and the second victim. So, you will be you have to actually add off and this would be the vertical summation; not the horizontal summation. So, remember that in case of social good or social bad the; if you have to find out the and the aggregate of anything, any social good or social bad; so, it should be added of vertically.

So, now as you understand this damage pollution damage is a social bad. So, therefore, the marginal damage function for the society or the total marginal damage function can be summed up this is vertically. So, this MD 1 and M 2; MD 2 are vertically summed up in order to find out the aggregate damage function right; let us say this is the aggregate damage function ok.

So, after finding this individual damage function from the pollution MD 1, MD 2; we are finding the what is the total damage function that the society is suffering from. So, based on these we can find out what is the optimal level of pollutions. So, what is the optimal level of pollution? So, simply you can find out this optimal level of pollution is reached by the intersection point of your marginal saving or the marginal cost function minus of that is also the minus of marginal costs function with the marginal damage function.

So, now you are saying that at this point; this is the aggregate marginal damage and this is the aggregate marginal saving or marginal cost minus of marginal cost function at this point E, the optimal amount of the pollution is reached.

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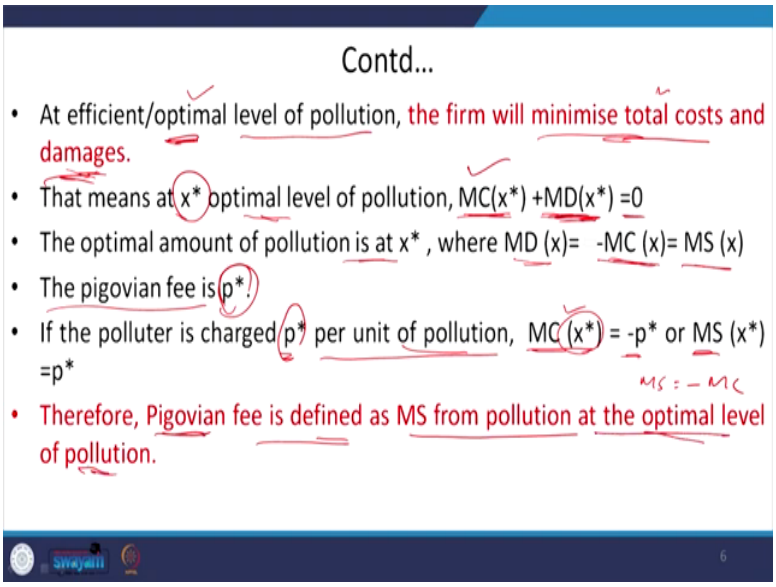

So, now how you are finding this optimal level of pollution? So, are this optimal level of pollutions the firm must minimize the total costs and total damages that is what the optimal level of pollution can be defined right. So, that means, if you are saying in this diagram if you are saying that this is the intersection point of marginal damage function and your marginal saving function and you are finding this optimal level of pollution that is x star and the price for producing this optimal level of pollution is P star ok.

So, now you can find that this efficient or optimal level of pollution that is x star the at this point; the firm must minimize the total cost and total damages as well. So, what we are saying is that at this point x star which you are saying this is the optimal level of pollutions, the marginal costs function with related with the pollution at these efficient or optimal level of pollution and marginal damage at this efficient level of pollution must be equivalent to 0,

because we are talking about the optimal level of pollution and optimal level of pollution; obviously, the firm will be trying to minimize the total cost and damages right.

So, this is the first order condition that how to minimize the total cost and total cost and damages. We need to take into account the first order derivative of the total cost that is the marginal costs and we are also take into account; account the first order derivative of the damages that is the marginal damages. So, we are summing it up and making it 0 right.

So, what we finding that at this optimal level of pollution that is x star right. So, this condition is satisfied because this marginal damage costs right is equivalent to the marginal minus of marginal costs that is equivalent to the marginal saving of the pollution right. And here what we have found? That this pigovian fee is determined as p star by the intersection point of your marginal damage and marginal saving function right. And if this pigovian fee p star is charged per unit of pollution right, then what we will be finding that this marginal cost of producing pollution would be equivalent to minus of p star or which is also marginal equivalent to marginal saving.

So, what you are saying this marginal cost of x star is equivalent to minus of p star or you can say marginal saving of at this point optimal level of pollution is equivalent to your p star ok. Because we are saying marginal this is the marginal saving is equivalent to minus of marginal cost ok.

So, therefore, what you are saying introducing from this discussion that this Pigovian fee that is p star; it is defined as the marginal saving from pollution at the particular point which particular point. So, this is at the optimal level of pollution right. So, this optimal level of pollution is x star.

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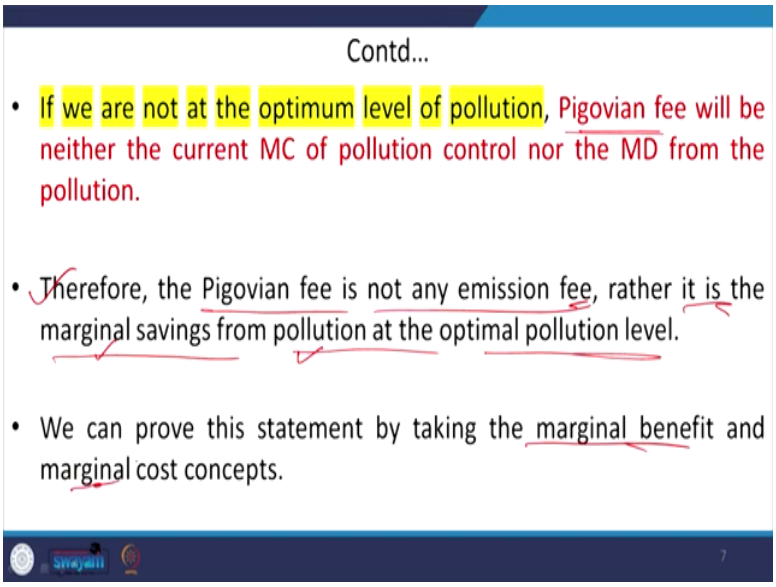

But if you are not take into account this optimal level of pollutions so; that means, we are not considering the only point x star right, we are talking some other points of pollution.

Then this Pigovian fee that is p star; it is not actually the current marginal cost of pollution control nor the marginal damage for the pollution that we are that is generated right. Because of this region that this at this optimum if you are not take into account or beyond the optimal level of pollution, this Pigovian fee is neither the current marginal cost of the products this pollution control nor the marginal damage from the pollution itself.

Because of this region the Pigovian fee is not an emission fee right rather it is a special marginal savings from pollution at the optimal level of; optimal level of pollution itself ok. So, we can actually verify that how this is and this is not an emission fee rather it is a special case

of emission fee which is taken into account take into account the marginal savings from pollution at the optimal level of pollution itself ok.

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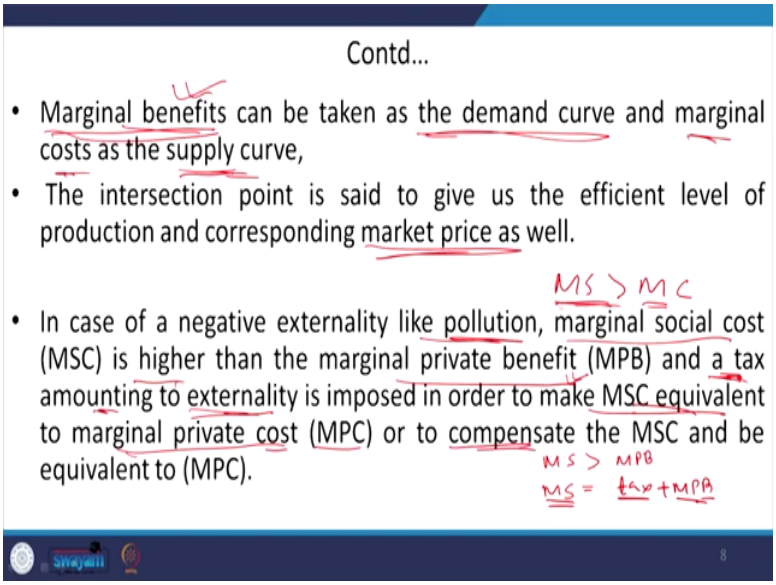

So, for proving this we can take this marginal benefit and marginal cost concept from the; economic activity of the firm itself right. So, what you can do is that if you have to find this marginal benefits we can take this marginal benefits can be interpreted as the demand curve and this marginal costs, it can be taken as the supply curve. So, this is the standard micro economics principles.

And; obviously, when you are talking about the efficient level of production; we can find this efficient level of production by take into account the intersection point of these two marginal benefits that is demand and marginal supply costs; marginal cost curve that is the supply curve

right. So, we are take into account this demand and supply factor into consideration for finding the efficient level of production.

And we can also find out at that point, we can also determine the market price for the pollution itself. And again we have already understood that in case of externality; let us take the negative externality like your emission or pollution, this marginal social cost is; obviously, much higher than the marginal private cost right. So, and also this marginal social cost is also not take into account the other concept like I mean your externalities.

So, in this context the marginal social cost is higher than the marginal private benefit and marginal costs itself. And when we are finding these this problem that is marginal social cost is greater than the marginal cost or this marginal cost is a also taken as the marginal private benefit because it is the firm will be getting benefits by producing more and more of output and generating more and more of pollution.

So, in this case we can take this tax right; we can consider a tax to be imposed right for this externality concern so that this externalities can be adjusted or internalized. So, what you are saying that this marginal social equivalent to this marginal private cost; it will be equivalent. So, what you are doing that we understood that this marginal social cost is greater than the marginal benefit right marginal private benefit.

So, in order to make these to equivalent what we are saying; this marginal social cost to marginal. So, what we are doing that we need to add the tax itself right. So, this tax plus marginal private benefit in order to make this equivalent to the marginal social cost so that what we can say that we can compensate the; the externality ok.

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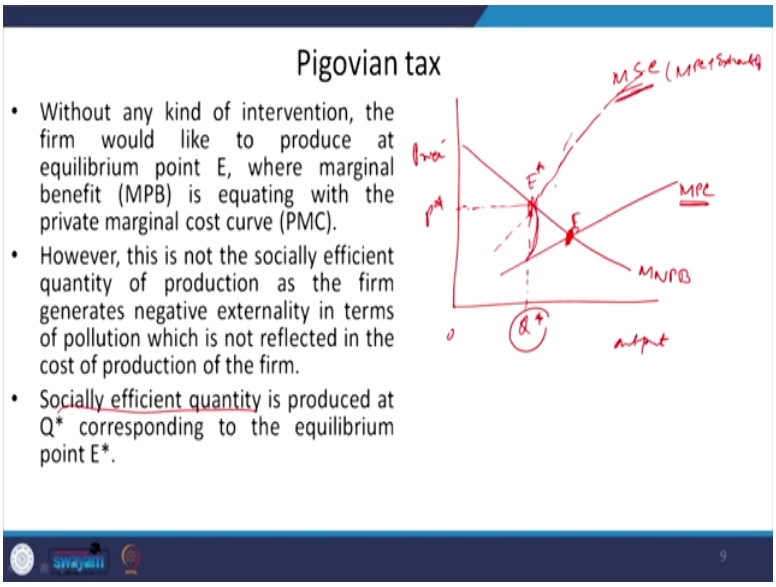

So, from our previous discussion we know; what is the Pigovian tax itself and in this in this case, we will be just highlighting that how this Pigovian tax is a special case of the pollution fee or pollution tax right.

So, what we are saying that we can prove this by take into account a graphical representation, we are in the x axis we are measuring the output and in the y axis we are measuring the price. So, the marginal private cost; this is the curve and this marginal net private benefit, it is also there marginal; marginal net private benefit. And if there is no intervention from any regulator or there would be no kind of regulation from the government side or any regulating authorities, then; obviously, the firm will be interested to produce at this equilibrium point.

So, what is the equilibrium point? Where the marginal net private benefit that is the demand curve is intersecting the marginal private cost that is the supply curve right; so this is the point

of intersection. So, without any intervention the firm will be interested to produce at this point; at this point E right. But; however, this is not a socially efficient output and social efficient price right. Why? Because here the marginal private cost is actually less than the marginal social cost; that means, externalities is there.

So, in order to find the socially efficient quantity, we need to find out what is the social marginal social cost right. So, what about the marginal social costs? So, that would be the marginal private costs plus the externality ok. So, let us say we have taken into account; this sorry externalities and this is the marginal social cost. What is marginal social cost? This is the marginal private cost plus externality. So, when this marginal social cost is intersecting the marginal net private benefit, we are getting this equilibrium that is E star right.

Now, corresponding to this equilibrium this Q star is the socially efficient quantity that is produced and the socially efficient market price is P star right. So, this is how we are finding that Q star is the socially efficient quantity because we have taken into account the marginal social costs here right and this marginal social cost is marginal private costs plus this much of externality that we have taken into account.

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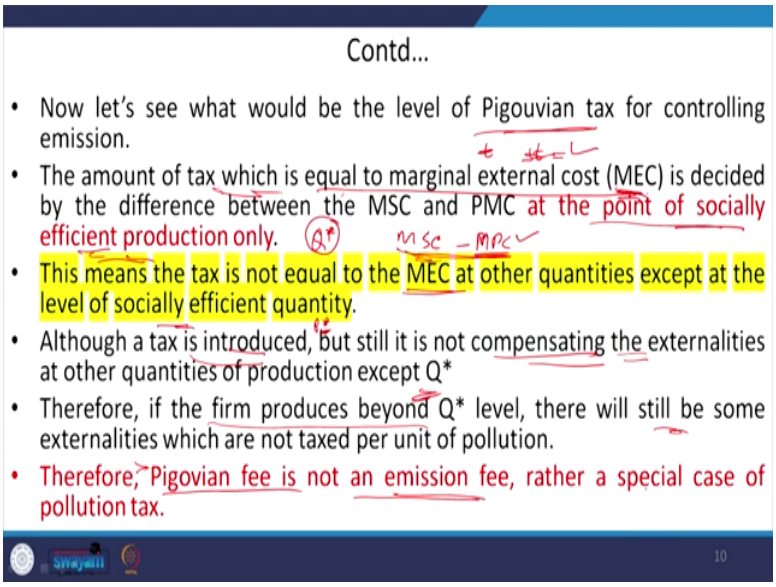

So, now we will be just considering what would be the level of this Pigovian tax for controlling the pollution itself right. So, what is the amount of this Pigovian tax or how what would be the extent of Pigovian tax? So, we know that this Pigovian tax is equal to the marginal external cost right. And this marginal external cost is decided, it is determined by the difference between marginal social cost and marginal private cost right at the point of socially efficient production.

So, what is the socially efficient production that we have discussed? It is the Q star in the last graph that we have discussed and there we are finding what is the marginal external costs. So, marginal external cost is the difference between the marginal social cost and the marginal private cost right.

So; that means, this the Pigovian tax that is equivalent to your marginal external cost which is determined by the difference marginal social cost minus marginal private cost ah; this tax is equivalent to the marginal cost right, at the point of socially efficient production only so; that means, at Q star only this a t is defined as the marginal external cost. So, t at Q star this Pigovian fee is equivalent to the marginal external cost which is equivalent to the marginal social cost minus the private marginal cost right.

So; that means, we can say that this tax; Pigovian tax is not equal to this marginal external cost. If you are take into account the other quantities or other points; so, except the socially efficient quantity right. And even though we are saying this tax is introduced that is P star amount of tax is introduced right, but still it cannot actually compensate the externalities present at points other than the Q star ok.

So, therefore, what we are saying that if the firm is producing beyond Q star that is optimum level of externalities; then there will be some kind of externalities still present right which are; which are not going to be tax, if you are following the per unit tax per unit tax for pollution.

So, because of this following logic that we have already made; this Pigovian fee is not actually an emission fee, rather it is a special kind of pollution tax. Why? Because; this Pigovian tax is only applicable when we are take into account this socially optimal level of output; so if we are take into account any other point any other point beyond the socially optimal level of output or socially optimum level of pollution, that is Q star then this Pigovian fee is not actually going to address this externality; that means, some kind of externality will still be present although we are imposing this Pigovian tax which is equivalent to your marginal external cost you are saying right.

So, now let us discuss that how this Pigovian fee is imposed when there are multiple sources of polluters right.

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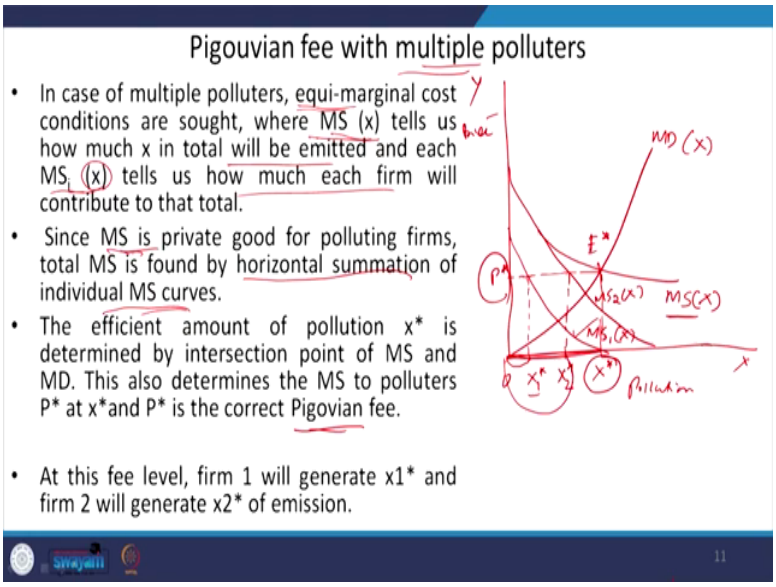

So, here the basic rule that we are take into account in case of this multiple polluters; we are following this equi marginal cost conditions right. So, this is the another very common principles we are using in micro economics this is equi marginal cost conditions.

So, where in a case of multiple polluters we are take into account the marginal saving function of the pollution right and we are also take into account the individual marginal saving function of each individual polluters. So, let us say this MS x is the total marginal saving function of all the polluters. So, this MS x is telling us how much of pollution in total can be emitted by all the polluters right and when you are talking about the individual marginal saving function right corresponding to this level of output. So, it is telling how much each firm or each polluters they will be contributing the total marginal saving for the pollution ok.

So, we can show this we can actually explain this in terms of a graph. So, in the x axis we are take in to account the pollution and in the y axis we are taking into account of price. So, what you are saying? That let us say there are two polluters; polluter firm 1 and its marginal saving function from polluting is can be denoted as MS 1 x and there are also another polluting firm and its marginal saving can be denoted as MS 2 x right and we are also finding the marginal damage from the pollution of the two firms. So, this is marginal damage of pollution; so this is x is your pollution ok.

So, now what we need to find that we know this individual marginal saving function from firm 1 and this is MS 2 is the individual saving function from the pollution for the firm 2 right. So, what we need to find out is the total marginal saving function ok.

So, how to find out this total marginal saving function? So, now we need to be careful that what kind of good; it is whether this marginal saving function from the pollution whether it is a private good or a public good; obviously, it is a private good. So, since this marginal saving is a private good for both the firms and the firms will be actually taking the benefits of this marginal saving functions right. So, the total marginal savings it can be found by the horizontal summation of the individual marginal saving curves right.

So, how you will be finding the; so, this is this will be your total marginal saving functions right. And now we need to find out what is the efficient amount of pollution how to find? Obviously, it is the efficient level of pollution is found by the intersection point of your marginal saving function which is the summation of all the marginal saving curves and the marginal damage function. So, this is the point let us say it is E star and there we are finding; this is x star right, this is the efficient amount of pollution.

And what is the corresponding price level; for this pollution? It is P star and this P star is said to be the pollution fee or in this case it is the Pigovian fee because it is determined at the efficient level of pollution right. And at this P star firm 1 will be generating; obviously, the total pollution to be generated each o x star. So, what is the portion of the pollution that is to

be generated for by the first firm? It will be found out by this P star when it is crossing the marginal saving function of the first firm; so this is x 1 star.

So, the firm 1 first firm will be generating o x 1 star this much of pollution likewise for the firm 2; it will be generating how much? This P star is intersecting the marginal saving function of the second firm at this point and corresponding to it we are finding this let us say this point is x 2 star right. So, now the firm 2 will be generating this o x 2 star this point; this amount of emissions ok.

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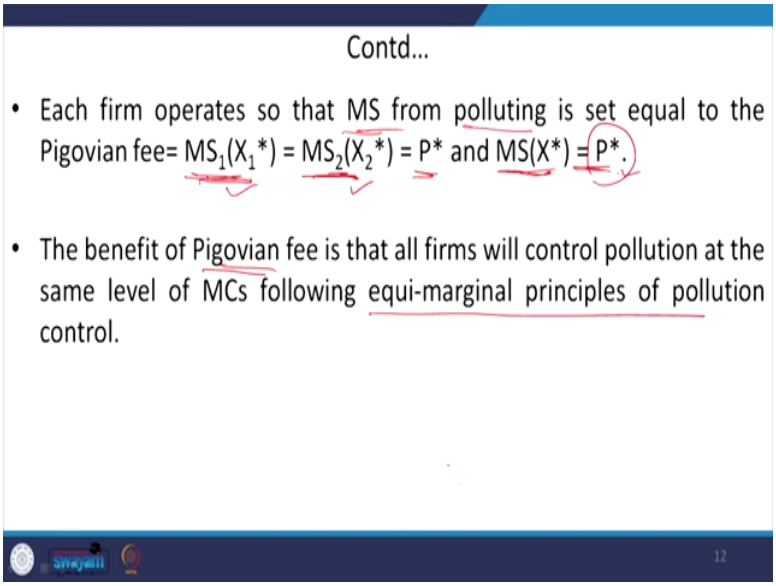

So, now what you are saying that each firm; they will be operating right in such a way that this marginal saving firm polluting will be equivalent to the Pigovian fee. What you are saying this marginal saving is equivalent to your pollution fee; that is Pigovian fee here and moreover the individual marginal saving functions would be equivalent to each other. So, marginal saving of

the first firm will be equivalent to the marginal saving of the second firm which will be equivalent to the pollution tax itself right.

So what is the meaning of it? That means, a the Pigovian fee right is take in to account and following the equi marginal principles of pollution control and that is why at this fee Pigovian tax or Pigovian fee; this equi marginal principle is followed where marginal saving function of the first firm is equivalent to the marginal saving function of the second firm which is equivalent to the Pigovian tax itself.

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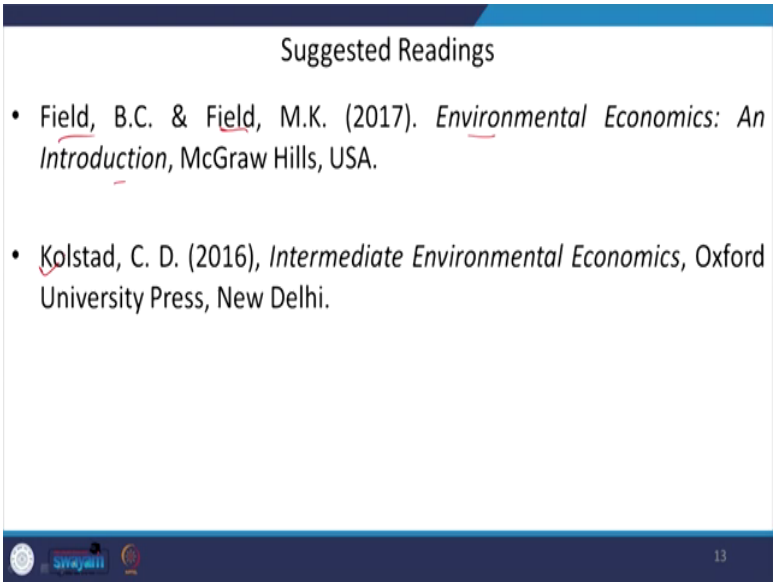

So, this is how you can follow the in; these books the first one is Environmental Economics; An introduction by Field and Field and the second one you can also follow this Intermediate Environmental Economics by Charles D Kolstad. And in the next lecture, we will be

continuing with the same instruments; this is market based instruments and we will be discussing the case of the subsidies, the second case is the subsidies ok.

Thank you very much.