Introduction to Environmental Economics
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Lecture – 42
Consumer and Producer Surplus - II

Dear students, the topic on Consumer and Producer Surplus was in discussion. I have already explained you the concept of consumer and producer surplus. Now, let you know, how to calculate these two surpluses consumer surplus and producer surplus? For this you should know demand function and supply function.

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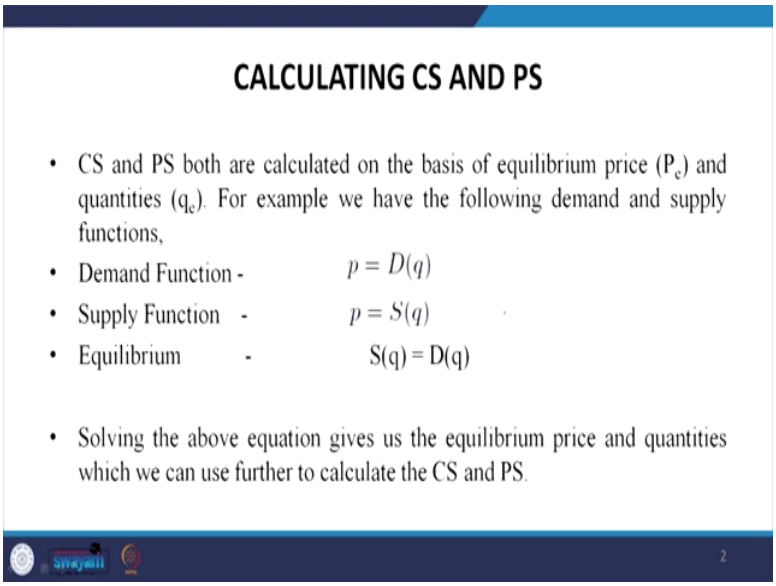

And at the point where the both the functions are equal to each other or at the point where demand curve intersect, the supply curve equilibrium level of prices determined. And, that

equilibrium level of price and quantity is known as market price and market demand. By solving these two functions or equating these two functions, we can estimate the quantity q and market price and then on the basis of these two estimates we can know consumer surplus.

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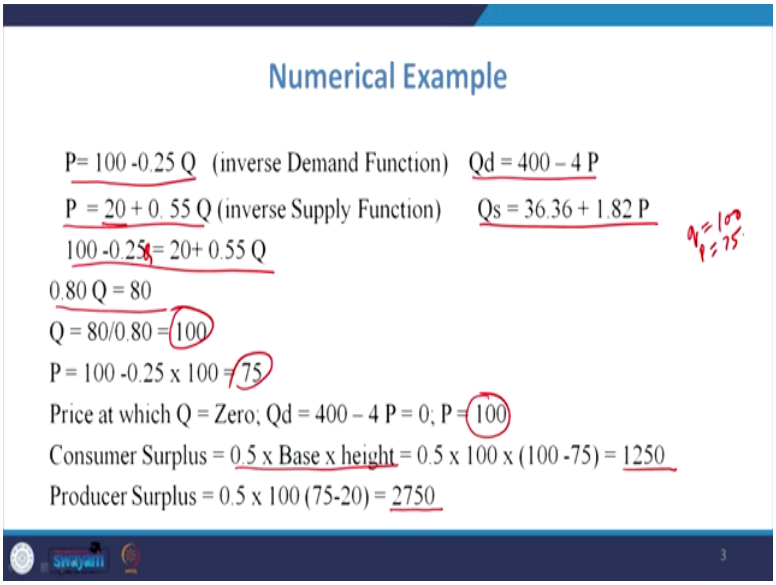

Let me take an example to explain you the consumer surplus. We have inverse demand function and inverse supply function P is equal to 100 minus 0.25 Q. So, this is our demand function. Now, from this you can also know the slope of the demand curve, when you have a linear demand curve. If, you differentiate this function dell P divided by dell Q, then you will get 0.25 minus 0.25, that is called slope of the demand curve.

Since, there is a minus sign so; the demand curve is having a negative slope indicating the inverse relationship between the price of the product and quantity demanded. This price

function can also be converted into demand function. So, this P is price function, which is called inverse demand function, can be converted into demand function. And, now we have Q d equal to 400 minus 4 Ps.

So, 4 P that is the demand function. Similarly, we also have the supply function P equal to 20 plus 0.55 Q. And, here you can also know the supply slope of the supply curve. If, you differentiate this function with respect to Q, then the this partial slope is known as supply curve.

And, this is constant indicating that, there should be a minimum price, which is necessary for producers to supply the goods in the market. And, that minimum price actually depend upon the fixed cost. So, if the price is not recovering these this kind of fixed or variable cost etcetera, then the producer would not be able to supply the product in the market.

Now, you can also convert this function into supply function. And, that is 36.36 plus 1.82 P is the supply function and we can estimate the equilibrium level of price and quantity by using both the functions. Either you can take price function or you can take a demand function and supply function to calculate the equilibrium level of price. So, here this is where Q, you can say the demand function and supply functions are equated. So, 100 minus 0.25 this is Q here missing.

So, minus 100 minus 0.25 Q equal to 20 plus 0.55 Q. Now, you can further simplify it then you will get 0.8 Q equal to 80. And, Q is 80 divided by 0.8 and that becomes 100. So, 100 is the equilibrium level of quantity. And, by putting value of Q into the function, you can also get market price. So, 100 if you take this price function or either this Q d function for example, Q d is 400 minus 4 P and if you put the 75 P is the 75.

So, 4 multiplied by 75 and here 400 minus 4 into 75, then you will get the price. This or 4 P equal to you can see from this P equal to 100 minus 0.25 and, since Q is here 100. So, 0.25 multiplied by 100 is 75. So, P is 75 this. So, 100 minus 0.25 into 100 equal to 75 so, here we had 2 values; one is equilibrium quantity Q is equal to 100 and P is equal to 75.

Now, you can also know at what price the quantity is 0. Q d is equal to 400 minus 4 P. So, if price is 100 then minus 4 multiplied by 100 minus 400. So, 400 minus 400 Q d becomes 0. So, maximum price at which the consumer is not willing to purchase any quantity is 100. Now, you know the market price 75, you know the equilibrium level of quantity 100, you know the maximum price the consumer willing to pay, then you can easily calculate the consumer surplus and the formula of consumer surplus is 1 by 2 base into height.

So, 1 by 2 means 0.5 is our this is 1.5 1. 1 by 2 equal to 0.5. So, 0.5 multiplied by 100 then 100 minus 75 equal to 1250. So, consumer surplus here is 1250. Similarly, you can also calculate producer surplus. And, producer surplus is 0.5 multiplied by base that is equilibrium level of quantity 100, then the difference between the minimum price, which the producer is willing to except for a particular first unit or 0 unit you can say, then and the equilibrium level of price. So, 75 minus 20 equal to 2750. So, this is our producer's surplus.

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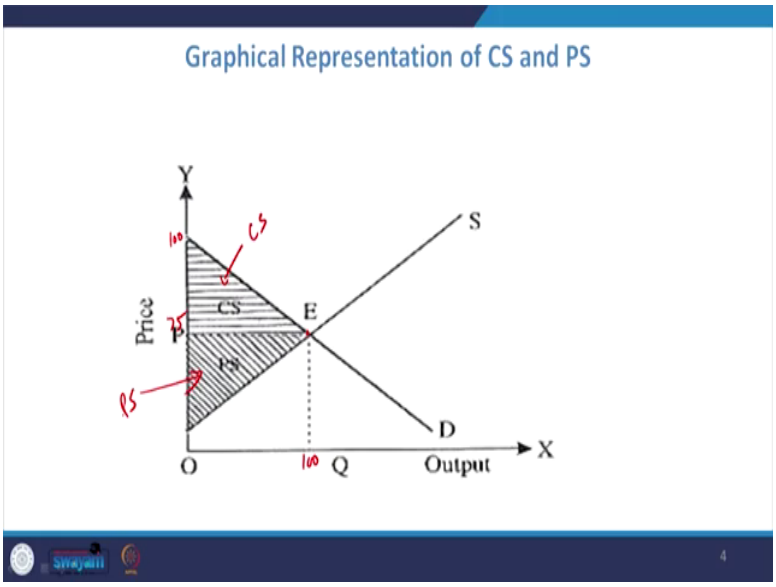

Now, this can easily be known you can see in this graph or I can simply use it, how much is the 100, 100 or let me check how much yes. This is the 100 is the maximum price and equilibrium level of price ok. So, here Q is 100 P is 75 and maximum price is 100. So, this is 100 and Q is 100, P is 75. Now, you can easily calculate so, consumer surplus and producer surplus. So, this is our consumer surplus and that is producers, producers surplus.

Now, one important aspect here is that, if there is a change in the price of the product. As we assume that price is given, but if there is a change in the price of the product then the welfare of the consumer will be affected positively or negatively depending upon, how the price is changing.

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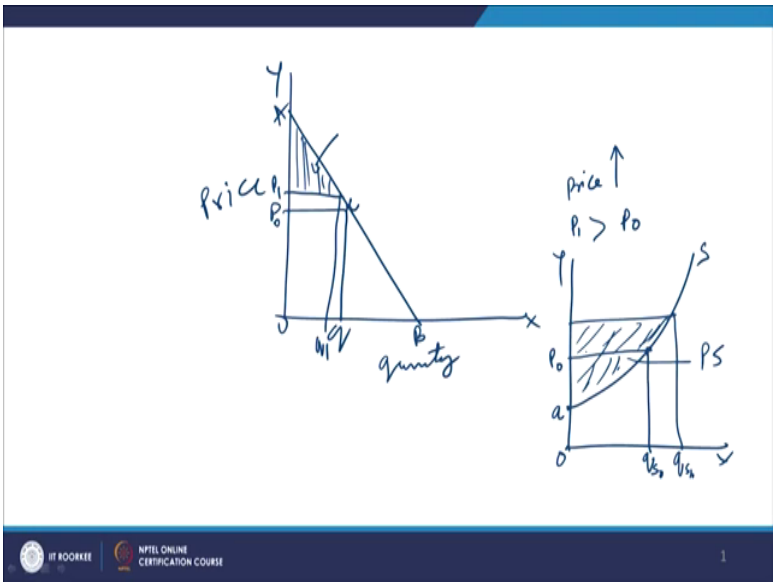

Take the demand curve. This is our linear demand curve A B price is taken on vertical axis and quantity is taken on horizontal axis. This is our initial price say, O P and quantity is O q and this is our consumer surplus. So, P A C this is our consumer surplus. Now, if the market price increases, if price increases and this P 0 becomes P 1 and P 1 is grater than P 0, then what happens price will go up and quantity demanded goes down.

But, at the same time the this area of consumer surplus also declined. And, this is a reason why the common assists always worried about rising prices of various commodities. So, when the price of various commodities increased in the market welfare of the consumer also falls, that is why when there is a high rate of inflation in any country and especially for the essential commodities, people start as you think against the raising prices, because it erode the welfare of the consumer.

So, very important that how the price of the product is moving, whether price is declining or going up that will also affect that consumer surplus. But, at the same time you can also see, how the price change affected the producer surplus. You can take if this is the supply curve and this is the point, where the producer is not willing to supply any commodity say a point.

And, if market price is O P 0 quantity supplied is 0. And, now this area is producers surplus, producer surplus. Now, if market price increases, then quantity demanded quantity supplied also increases and producer surplus now becomes larger. So, obviously, the producer would like to have higher price of their product because it will include their producer surplus. And, consumer would like to pay less price of the product, because if consumer is going to pay less price it will increase their producer consumer surplus.

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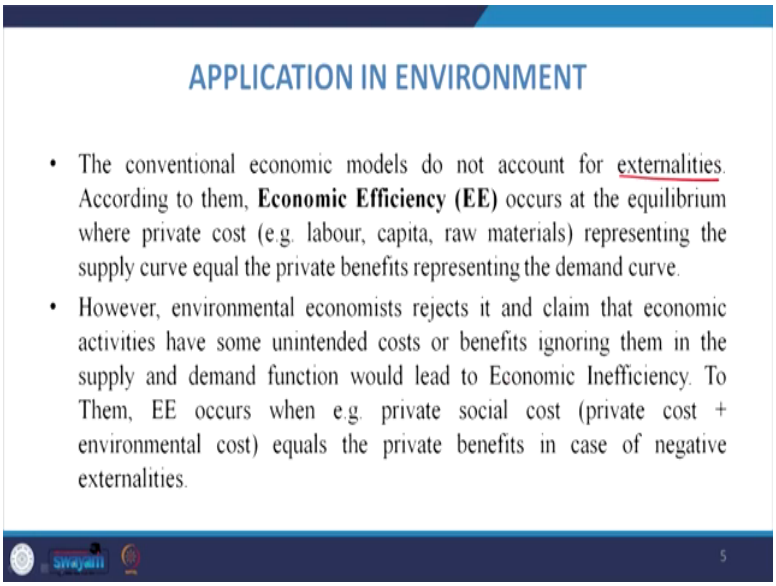

Now, application in environmental economics of these concepts, the conventional economic model do not account for externalities. I already explained what is externality? A externalities are unintentional harm or benefit received by a person not directly involved in the activities.

So, according to economist, Economic Efficiency occurs at the equilibrium where private costs, which include capital cost, labor cost, raw material etcetera, representing the supply curve equal the private benefits representing the demand curve. As, I already discussed that, price of the product and economic efficiency is achieved at the point where supply and demand curve of a firm intersect each other's.

But, here this supply curve or marginal cost includes only the private expenses involved to produce the goods not the external cost of the production. However, environmental economist reject it and claim that economic activities has some unintended cost or benefit ignoring them to the supply and demand function and would lead to economic inefficiency.

So, market distortion actually occurs because of presence of externalities. So, externality is very very important, because if you are not internalizing the externality, then the society will bear the cost of the production of goods which do not include the external cost like pollution, while estimating the cost and benefits of a particular activity.

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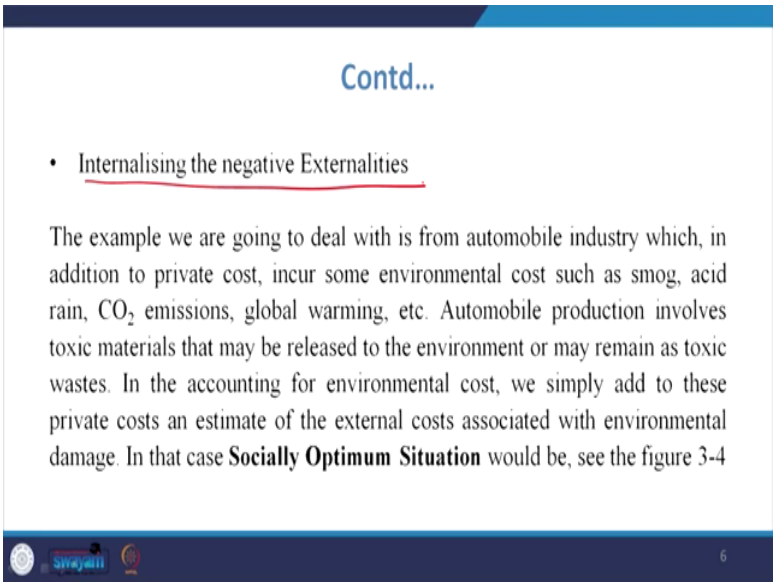

Internalization of negative externalities, how can we internalize the externality we can simply explain by a graph.

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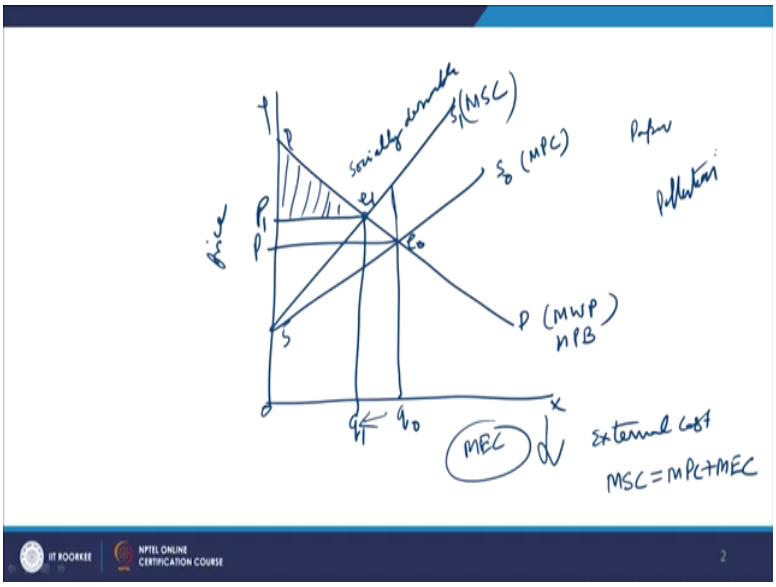

For example, we take a case of any industry, you can take any example most polluted industries like cement, steel, paper. So, you can take say paper industry. And, paper industry is producing paper and having a supply curve like this S S and demand curve like this DD. So, DD is our marginal willingness to pay. And, this is or that it also called marginal private benefit. And, that is also called marginal private cost. And, this is equilibrium output O Q and O P is the price.

Now, this supply curve does not include external cost, external cost. Now, how you take this external cost, whether you take it as a per unit in case or lump sum, that will tell us what will it the shape of this marginal social cost. So, marginal social cost, marginal social cost is marginal private benefit plus marginal external cost. And, since we are taking marginal and it

may increase or decrease depending upon or it may be a constant then a constant will be added or it may have a slope, then curve may be like this ok.

So, this is marginal social cost. And, now the new equilibrium is achieved at point e 1 earlier it was e 0 and quantity demanded is O q 1 from O q 0. So, this is a new equilibrium, that you can say when or socially desirable equilibrium point. Because, now the external cost is included in the function and now the price will go up.

So, now, when you look at the consumer surplus? Of course, since here consumer surplus is the difference between what the consumer is willing to pay and what the consumer actually paying? Now, consumer is actually paying higher. So, consumer surplus also declined due to this, but society is going to gain, because of this because when the polluted industries reducing the output.

So, when output is reduced then marginal external cost or total external cost will also reduce. So, pollution will also reduce when output is reduced and in that case the welfare of the society at large will increase. So, here the it is very important how you internalize the externality. There may be various methods to internalize the externality. One is that polluters pay principle is followed by many countries including India, Indian environmental policy also focuses that a polluter is polluting. Then, the entire cost of the pollution should be recovered by the government from the polluters. So, polluters must put that cost into the entire production pro system.

So, if it is taken into the system then the supply curve will shift upward. And, new supply curve S 1 will be that is called marginal social cost curve and new equilibrium will be achieved at higher level of price and lower level of quantity. So, that obviously, will also reduce the producers surplus as well as the consumers surplus, but at the same time society at large would be benefited because of this. So, this is one way. Second way, maybe that we can impose pollution tax; pollution tax and many times government also make provision in the budget.

That some additional cess can be imposed on motor vehicles or other areas in order to recover the cost of the pollution that is generated by either consumer, when consumer is polluting the environment, while consuming the product or producers when producer is polluting the environment. So, pollution tax can be imposed. But, more or less the effect would be same, when a tax is imposed then the supply curve will shift upward. You can easily see the similar kind of graph sup.

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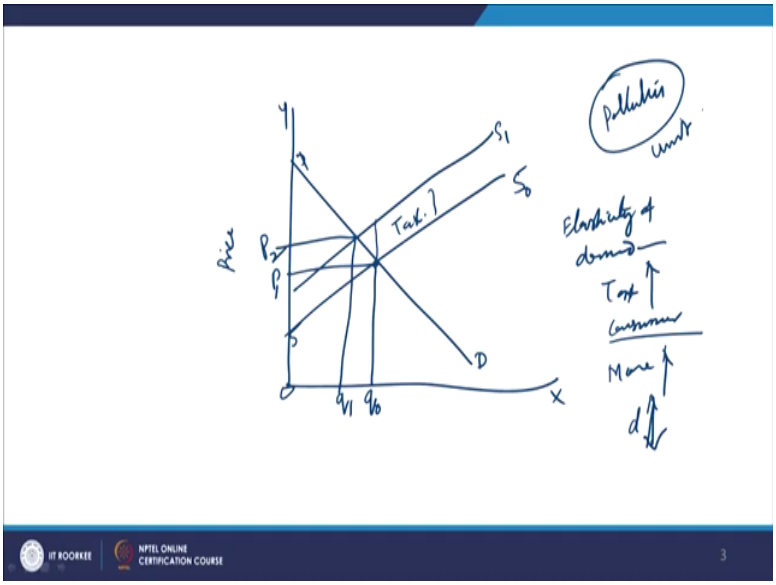

Suppose this is the situation before tax. If you take impose your tax on paper industry or automobile industries or so, sugar industry etcetera. Then, we have a supply curve, demand curve, this is our demand curve, this is our supply curve. And, now this is q and then the S 1 will be higher and that indicate tax.

So, tax also displays the production of polluted industries from q 0 to q 1 market price from P g 1 to P 2. So, ultimately whether polluters in internalizingthe externality by treating the waste before releasing into the atmosphere, or government is imposing the tax on the polluters, ultimately the burden would be on consumer.

So, all these taxes are passed on to the consumer by raising the price, but as the student of economics we know, how much tax will be passed on to the consumer, how much will be borne by the producer that actually depend upon the elasticity of the demand, elasticity of demand? So, if elasticity of demand is less elastic of a particular product. And, if tax is imposed on that pollution tax is imposed on such product, that then the maximum burden would be on consumers. Yes, consumer demand will not declined due to the increase in or declined in a lesser magnitude when the price is increase due to the increase in taxes.

But, if elasticity of demand is more elastic, then what happen if the company will try to shift, the pollution tax on the consumers by raising the price then demand will come down drastically. This demand, when demand comes down it will also affect the revenue position of the company.

So, company may bear part of such tax itself and partially can be shifted to the consumers. So, but immediate effect of taxes is that, it will improve the welfare of the societies, because by imposing pollution tax we can decrease the production of polluted products or those who pollute the environment. And, what will be the results? If more tax are imposed on the product of the polluted industries, then what happens, they will go for R and D; Research and Development activities they would try to release less pollution per unit of output produce and that will help the society at large.

So, that is why sometimes we say that, this market based approach of environmental protection is more effective, because it increase the R and D, Research and Development activities, if we are imposing taxes per unit of pollution generated. So, if pollution is generated and if we imposed unit tax per unit tax on the emission generated.

Obviously, when a company is releasing more waste, then more tax will be paid pollution tax will be paid by the company. And, next time the company would like to evolve some strategies to reduce the emission per unit of output produced. And; obviously, if this kind of strategy is adopted by the company, then it will benefit the society. So, welfare of the society will improve due to imposition of pollution tax.

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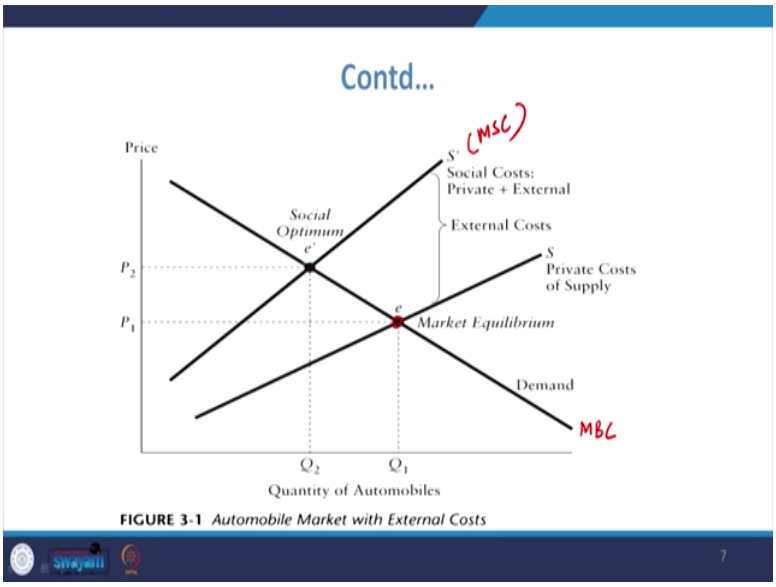

So, that is what you can see from these graphs. Like, the same things which I already explained, you we have a demand curve, we have a supply curve, market equilibrium is achieved at the point where supply and demand curve, intersect each other and market price is O P 1. Now, if we wanted to include the marginal external cost or externalities included, then the supply curve will shift from this private cost to new supply curve, which is also known as marginal social costs.

And, marginal social costs intersect the marginal benefit curve at point e 1. So, moment from e to e 1 is at higher level of price and lower level of quantity. So; obviously, that reduce the pollution in the economy.

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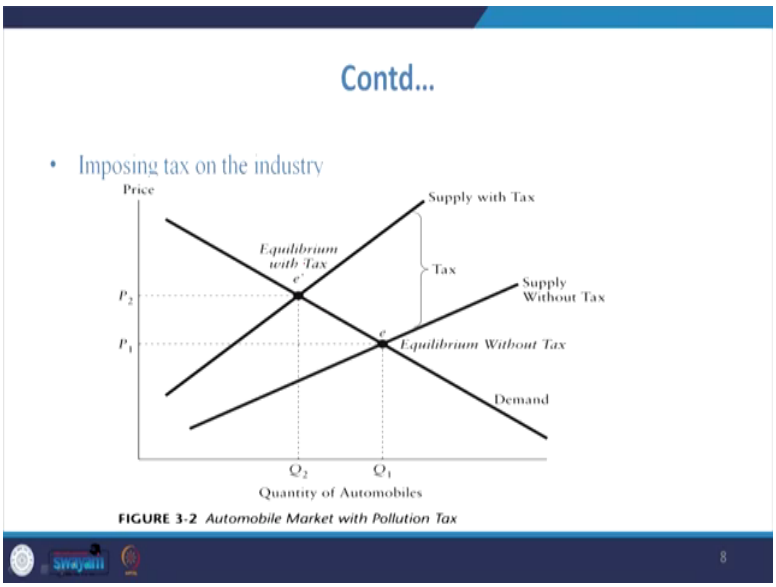

Similarly, you can I already explained you, when you impose the tax then tax will also shift the supply curve, and the if tax is imposed the company will set the price at higher level. So, imposition of tax on industry also shift the supply curve, and supply cost shift and intersecting digesting demand curve at point e 1, which is showing lower level of output and higher level of price indicating that.

Now, when tax pollution tax is imposed then company output will be reduced. And, if output is reduced and since company are generating externality pollution. So, if output the reduced pollution will also reduce and welfare of the consumer will increase.

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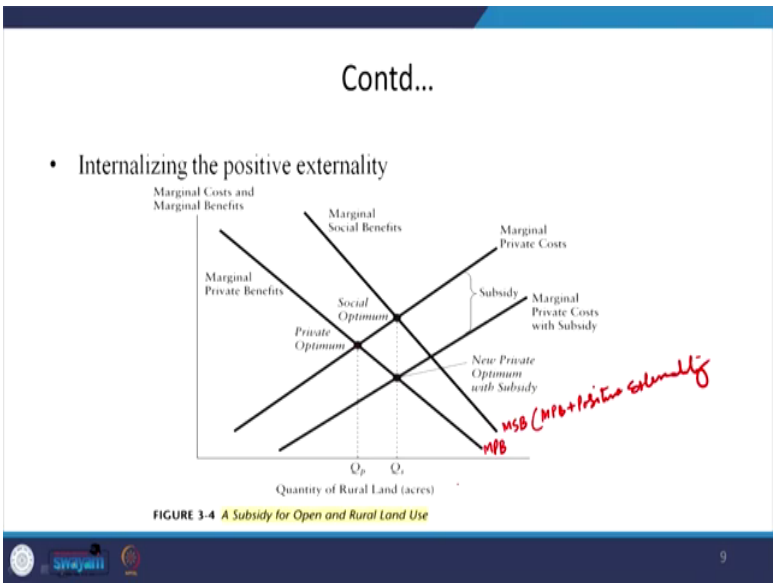

Similarly, it is very interesting that in some cases positive externally will also generated. As in the earlier lecture, I discuss that whether externalities negative or positive both distort the market. So, market efficiency is affected due to the presence of both positive or negative externalities, but positive externally is desirable, because it benefits the entire society like education for example.

In case if more expenditure's made on education and people are becoming more or more educated, then the educated people also generate positive externalities and that will help the society. So, if a society is spending more money on providing education and if people are

getting education, then it is benefit goes to the entire people through positive externality. Similarly, another good example of positive externality is be beekeeping and apple of chart. So, farmers there may be two farmers; one is growing apple, other is growing honey.

So, both generate positive externalities. Beekeeping people the bees get nectar from the garden and bees also help in pollination. So, the productivity of the farmer growing apple will increase due to the poly pollination. And, similarly productivity of the farmer growing honey will also increase, but it is not the intention of honey grower or apple grower to provide benefit to each other. So, it is unintentional benefit, but society is getting or farmers are getting benefit in the form of positive externality.

So, there are number of such example of positive externalities a private park can be constructed by a person for his or her own benefit, but people walk walking near to that park, may also enjoy the natural beauty of the park and they also extract utility. So, that is a kind of positive externality.

Similarly, there are number of examples like farmers may grow tree and they earn income by growing tree, but at the same time the government secret station occurs due to the plantation or tree like, popular trees wood farming is done by the farmers. So, that also improve a generate positive externalities.

So, there are number of examples of the positive externalities and when positive externalities created it improves the welfare of the society. So, in this example, in this graph you can easily see, that we have marginal private cost and with subsidy without subsidy. Now, initially we can see that the optimum level of output is achieved at the point, where the demand curve is intersecting the supply curve and this is the point. Here and at this point you know that quantity is determined and market price is determined.

But, in this example a positive externality is generated and so, marginal private benefit and this is say marginal private benefit, but this is marginal social benefit, which also includes

marginal private benefit plus positive externality. So, due to positive externality, now what happens the equilibrium shift at this point?

So, that is called socially optimum point, but when subsidy is included, then again the supply curve will shift. And, subsidy as we know when a subsidy is given to any factors of production or to any producer, then subsidy encourages the production; tax discourages the production. So, in the pre preceding example, I explained you how the pollution tax reduces the output just opposite to the effect of subsidy. So, when subsidy is given to any producer, then it will increase the production and that can be seen here this point.

So, this point is when the subsidy is given, especially a subsidy maybe given by the government to promote the green products like to generate social welfare in the economy. So, like government can provide subsidy on organic farming. And, if organic farming is provided subsidy it will generate positive externality. And, positive externality will shift the private marginal benefit to mar private social benefit and then it will go to this point, which shows higher level of so.

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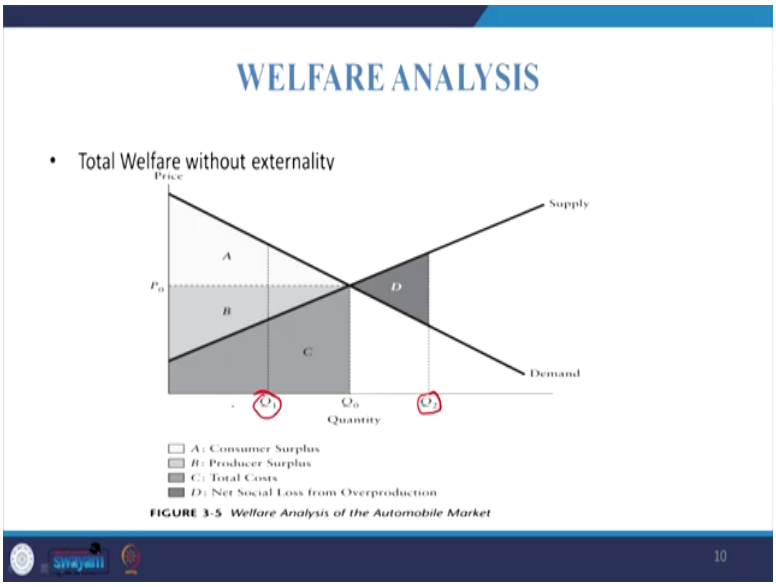

So, now, it will improve the welfare of the society by generating the positive externality, you can also know the welfare of the society without externality. So, if externality is not created or we can say this in two way. First that any economic activity in order to generating any negative externality or there may be some economic activity which internalized the externality.

So, if no externality is generated then supply and demand curve without externality will intersect each other at the point, this point, where equilibrium is achieved, and at this point you can see consumer surplus, producer surplus, total cost and net social loss to the society.

So, A part, this A part shows as we are already discussed consumer surplus. B part is indicating producer surplus, C part shows how much is the cost of producing the quantity, when O Q quantity is produce, O Q 0 then this total area is known as total cost, but if

company increases the output above the equilibrium level of output that is O Q is the equilibrium level of output.

So, if company is producing above this and produces O Q 2, then what will happen there is a gap you can see the gap between supply and demand and that this gap also clearly indicate D part. So, D part is the net social loss due to the over production of the product.

Similarly, if you produce at O Q 1, which is below the equilibrium point again you can see there is a gap. Here, the gap between the marginal willingness to pay for the price or marginal willingness to accept. So; obviously, this gap also create losses. So, losses occurs, the loss of the consumer surplus as well as producer surplus occurs, when you divert from the equilibrium point. Either you produce O Q 2 or O Q 1 in both way, the there is a loss to the society in terms of loss of the consumer surplus or welfare.

Now, total way welfare with externality again as we have already discussed this, when externality is taken into account or when externalities internalize, then the supply curve will shift upward.

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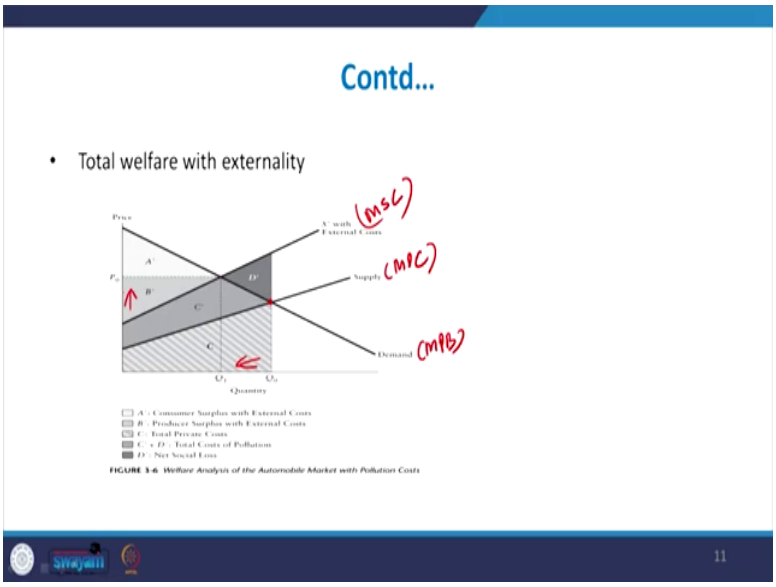

And, new supply curve will be supply curve which also include external cost or as we use marginal private cost and marginal social cost. So, marginal private cost is intersecting marginal private benefit, marginal private benefit at this point. So, equilibrium is at O Q level of output , but when external cost is added in marginal private cost, then we get marginal social cost. And, marginal social cost intersect the existing demand curve or marginal private benefit curve at this point.

And, now price is higher and quantity is lower you can see quantity declining and price is going up. And, that is also affecting the consumer surplus, but at the same time the net actually the gain of the society is achieved ok.

So, that is all about consumer surplus and producer surplus, let me briefly conclude what I have discussed in this lecture. I explained you the two concept consumer surplus and

producer surplus, I also explained how to estimate or how to calculate the consumer surplus and, producer surplus by using the linear demand function. I also explained how to introduce these two concepts in environmental economics, or assessing the welfare of the people in case of consumption various kinds of environmental goods or bads.

Thank you very much.