Microeconomics: Theory & Applications
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Lecture – 53
Externality & Market Failure (Part-2)

Hi, welcome back to the lecture series on Microeconomics. Let us continue our discussion on Externality.

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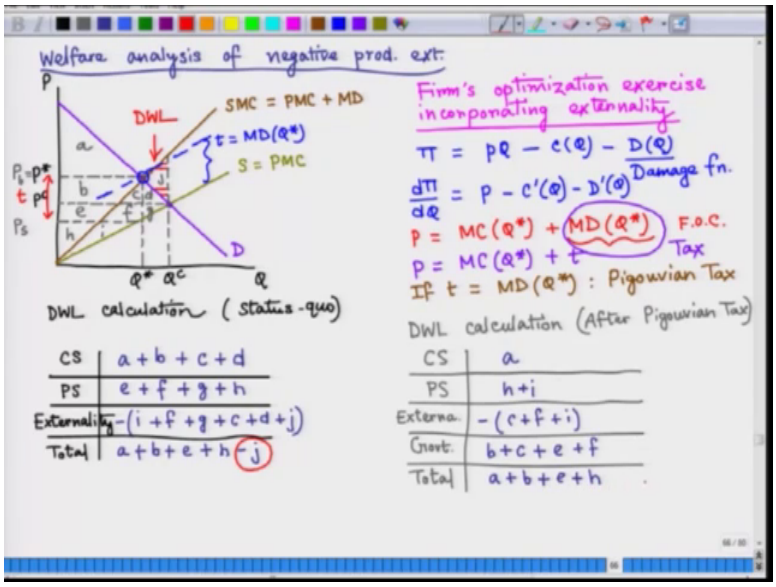

So, we have seen how to find out the dead weight loss associated with the negative externality. Now let us shift our focus to the positive externality. So, here also we are going to do a graphical analysis of dead weight loss calculation associated with that. So, first we have to understand, how do we accommodate the case of positive externality in a simple demand supply diagram. For that we have to understand that there is something known as external marginal benefit.

What is it? So, for each so, if there is a positive externality associated with one commodity's production and consumption. So, there is some societal benefit, which is not captured by the market price of the commodity. So, the total benefit accrued by the society is basically higher than the private marginal benefit, which is actually represented by the demand function for the commodity. So again, we have to shift either the demand function or the supply function to accommodate these externality case. We will assume

that these external marginal benefit, which is basically the additional benefit, which goes to the larger society from consumption of 1 unit of this commodity has some kind of functional relationship with the quantity being produced.

So, we are going to here assume that it is constant so; that means, that for each and every unit of quantity, production and consumption of this commodity basically, generates the same external marginal benefit. So, of course, this is the simplification we do not have to assume that, but if we assume the simple case let us, analyse the case of the simple constant marginal external benefit through the diagram.

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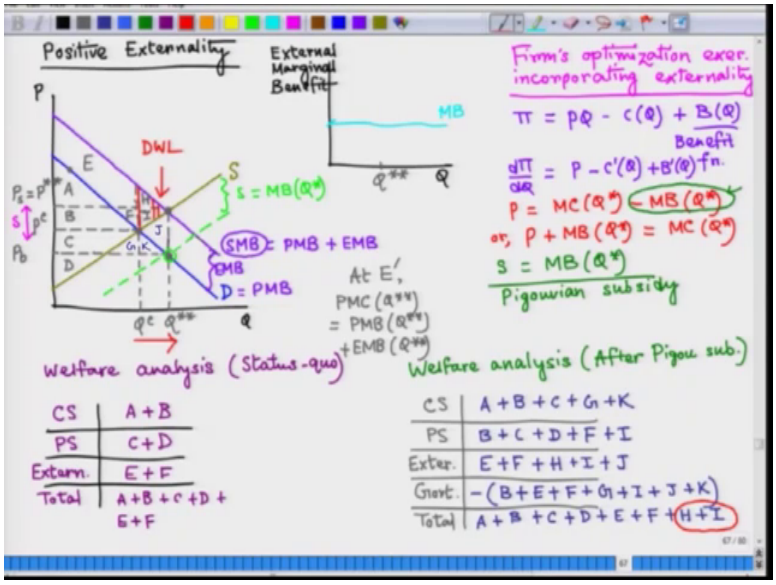

So, let us now, focus on the small panel of diagram, where I am measuring the external marginal benefit along the vertical axis and we assume that it is basically a constant number. So, as my quantity production and consumption goes up my external marginal benefit stays constant and that is basically some constant level which is basically given by the intercept here. And, this curve is known as the external marginal benefit curve or simply the marginal benefit curve ok.

So now, basically, we have to accommodate, this extra benefit in the normal demand supply competitive market diagram ok. So now, let us focus on the simple competitive market diagram, which we are going to draw in the larger panel. So here, in the larger panel, we see the demand and supply curves are drawn already and the intersection of

these 2 curves gives me my competitive market equilibrium denoted by E. So, we get the Q c amount of quantity and P c price at the competitive market equilibrium.

Now, how to accommodate the positive externality in the diagram; so, that can be done again in 2 ways. So, I can add this marginal benefit external marginal benefit to the private marginal benefit, which is basically given by each and every point on the demand function. So, if I do so then basically for a constant external marginal benefit, I am basically talking about summing of a constant number to the price corresponding to each quantity level. And, that will basically shift my demand function upward and the gap remains constant right. And the gap is basically, this gap I am talking about is basically, my marginal benefit right then that stays constant as per assumption.

So here, I get a new curve, which is basically known as social marginal benefit that is basically my private marginal benefit, which is basically given by my demand function. Because, each and every point on the demand function gives the marginal utility corresponding to the consumption of a particular level of output. So, that is basically benefit for the consumer and then I need to add this external marginal benefit. So, I can add E here that is coming from my constant marginal benefit for the larger society from consumption of this good. And that is basically, my true societal benefit that I obtain from the consumption of this commodity ok.

So basically, if I want to now find out the Pareto optimal market solution, I have to find out one particular price, which takes cares of or which captures the true social benefit marginal social benefit and the marginal social cost. So, that is obtained at the intersection point of the supply function and the social marginal benefit function and at the intersection a new PQ combination emerges right. So, let me say that this is P double star price and Q double star quantity of output. I claim that P is double star Q double star combination is basically, my Pareto optimal market solution.

Why? Because note that this P double star price actually, captures the private marginal benefit and the social marginal, external marginal benefit both of them. How? Because, note that if I look at the demand function corresponding to this Q double star quantity level of production and consumption there is this private marginal benefit, which is given by the point on the demand function right. So, we can say at E prime the Pareto optimal solution, the true societal marginal cost, which is basically, PMC Q double star, which is

to be rate from the supply function is equal to PMB, which is coming from the an individual consumer.

So, this is private and then there is this external marginal benefit associated with this level of production and consumption right. So, basically this is my new Pareto optimal solution and note that here, if I compare these 2 equilibriums perfectly competitive one and the Pareto optimal one, then we note that there is the problem of under production right. So, there is an alternative way to accommodate positive externality in the same demand supply diagram. So earlier, we have adjusted the demand function now, we can also adjust the supply function, how to do that? Let us revisit the graph.

So now, note that if there is a external benefit from production and consumption of a commodity that can be also seen through the supply function. Because, if that is the case then we can see that the private marginal cost of production is basically, higher than the true societal cost of production of that commodity because, it basically gives rise to external marginal benefit from its consumption right. So, basically if there is a constant marginal benefit as we have drawn and assumed for that we can basically, deduct that amount of external marginal benefit from the private marginal cost curve as well

So, if we do so then basically you are talking about a parallel downward shift of our supply function and then let me draw one such supply function like this. So, here I have drawn a new supply function say S prime, this S prime curve is basically what? So, this is basically my private marginal cost minus the external marginal benefit ok. So, this gap again gives EMB or the external marginal benefit. Now, note that if this happens then also the Pareto optimal solution will be Q double star output level only.

So now, we are going to look at the welfare analysis or associated with the positive externality case. So for that we have to draw some areas involves so, that we can do the analysis for that I need to clean this graph little bit ok. So let me now, erase some parts of the graph some things, I am going to erase ok. So now, let us look at this fresh diagram, we have erased several parts of it for a simple graphical analysis. So, that the diagram looks less cluttered. So, here you note that I am adjusting for the positive externality through the demand side.

So basically, we have erased all the supply curve changes and all. So, let us now also look at these areas that I have marked with different alphabets and with this alphabets,

now let us continue our discussion on welfare analysis. So now, we are going to basically focus on the welfare analysis ok. So, we will first start with the consumers. So, the consumer surplus associated with the perfectly competitive market is basically is a plus B right ok. Now the producer surplus associated with the competitive market equilibrium would be C plus D and of course, there is some external benefit.

Here which is positive and we see that it is basically, the area which is bounded by the private marginal benefit curve and the social marginal benefit curve and the vertical price axis and the vertical line drawn at the perfectly competitive market outcome. So, that is basically E plus F right. So, what is the societies total economic surplus or welfare? So, that is basically sum total of these 3 components. So, it is going to be A plus B plus C plus D plus E plus F right ok.

So now, note that as under perfect competition in the presence of positive externality, the commodity is being under produced, there is a loss in terms of the external benefit and that E that loss is basically given by these 2 triangles H and I. So basically, I can now mark this area of deadweight loss with these red lines. So we can we get another triangle of dead weight loss, this time associated with positive externality. So, now, we are going to study, how to encounter this externality problems in a mathematical economic model. So, basically we are going to discuss some policy measures, we are going to now learn about the work by a British economist Professor Arthur Cecil Pigou and he has basically shown us the way to internalize the externalities in a otherwise mathematical economic model.

So, let us now, revisit the firms profit maximization problem to incorporate both the positive and negative externalities and see what happens. So, let us talk about a polluting firm, it creates negative externality, it has a profit function which needs to be maximized right. So, P is the price Q is the quantity. So, this is revenue it is known to you, we have to subtract, the cost of production from the revenue to get the economic profit.

And now as this firm generates the negative production externality, we also have to deduct the damage caused, which is imposed upon the society from the production and consumption of this commodity. So, this is basically my damage function right. So, we have seen the diagram for marginal damage function, we have assumed particular shapes for that. So, this is basically my total damage function ok. So, now by incorporating this

damage function in the profit expression, we have internalized the externality in the firms profit maximization problem.

So now, the firm will try to maximize profit and this is going to be the first order condition right. We need to said that equal to 0 and if we do so, then basically we get back these condition P equals to marginal cost of the Pareto optimal level of output plus the marginal damage caused at that level of output right. So, this is basically the first order condition that we have ok. So, this is an extra element, in the first order condition, which we require if we compare, our latest first order condition to the perfectly competitive markets first order condition which is required to hold for first welfare theorem to operate ok.

So now, Professor Pigou suggested that what if we now incorporate attacks policy major in the model; so, as to take care of this marginal damage component right. So, Professor Pigou is suggesting attacks to take care of these component, in the first order condition. So, basically if I now talk about a unit tax then basically, my first order condition can be rewritten as this when T is basically my unit tax right. So, if the tax is equal to the value of marginal damage evaluated at the Pareto optimal level of output.

Then we call that tax as a Pigouvian tax named after Professor Pigou. So, now we are going to discuss, if Pigouvian tax is implemented then what is going to be the welfare implication of that tax? Before we do that tabular analysis of welfare calculation and deadweight loss calculation, let us see how a Pigouvian tax is to be implemented on the graph that we had earlier. So now, note that when we talk about some unit tax measure then basically, we are talking about a parallel shift of the private marginal cost curve such that the gap between the new curve and the original private marginal cost curve is basically equal to the marginal damage level measured at the equilibrium or Pareto optimal level of output.

So, basically we are talking about shifting our PMC curve to this broken line and note that this broken line will pass through, this intersection point indicating the Pareto optimal solution. So, this is the magnitude of the Pigouvian tax, which is exactly equal to the marginal damage evaluated at the Pareto optimal level of output fine. So now, we can concentrate on this table and we can fill this table with these areas. So, let us start with the consumer surplus.

So, the consumer surplus after the Pigouvian tax imposition will be the area a only because, now you see that you know the after tax imposition the price that buyer has to pay PB is much higher and the producer surplus will be h plus i. Because, after the tax imposition producer can keep only this much with them and then the third component is basically the externality component although, we have reduced the production of the commodity, but some externality will still be left in the system and for that.

We have some negative externality and that is exactly the area C plus F plus I and then as there is tax imposition by the government now, we have a fourth component in our welfare calculation and that is basically, government sector which is earning some tax revenue and the volume of tax revenue is this. So now, as everything is in monetary figure, we can sum and then the sum total will lead to this total economic surplus or social welfare in our model. So now, note that by imposing a tax, which is alternatively measured by this gap between P V and PS.

I have successfully eliminated the dead weight loss area because, it is not present in the new total economic surplus that we have found now, we can move ahead with our discussion to study, what is going to happen, if we internalize positive externality into a firms profit maximization model. So, we write pi PQ minus CQ. Now, note that production of this commodity leads to some positive externality. So, this time I will have some benefit function BQ. So, this is basically my benefit function right and this is external benefit we are talking about. So, if we can internalize externality in this manner then the firms first order condition will become right.

So, if you said that equal to 0 then we get this first order condition, which is price equal to marginal cost evaluated at private marginal cost evaluated at the Pareto optimal level of output minus marginal benefit evaluated at the Pareto optimal level of output right. Alternatively, we can also write price plus marginal benefit evaluated at Pareto optimal level of output shall equal to the marginal cost of production private marginal cost of production at that optimal level of output ok. Professor Pigou suggested that we can employ a subsidy economic policy to give positive incentive to the firm to produce this output more.

And how this is going to be done let us look at that. So, Professor Pigou is suggesting that the firm could be given a subsidy per unit of output, exactly equal to the marginal

benefit evaluated at the Pareto optimal level of output and if this is done then this is known as. So, if this economic policy is taken, this is called a Pigouvian subsidy. After Professor Pigou, who has first talked about this ok. So now, if Pigouvian tax is to be implemented in graph, how we are going to do that? So, either we can shift the marginal cost curve. So, let us talk about the first order condition the first firms.

So here we see that we have to deduct the positive marginal benefit from the private marginal cost. And if we do so, then basically we are talking about parallel downward shift of the private marginal cost, which is basically our supply function and that I denote by these broken line and the difference between these broken line and the original supply function gives us the magnitude of the Pigou subsidy and that is basically, exactly equal to the marginal benefit evaluated at the Pareto optimal level of output right. So, this broken line intersects my demand function at this point the Pareto optimal level of output is determined for the society.

Now, we are going to see: what is the welfare implication; if government adopts a pigouvian subsidy economic policy to internalize the positive externality of accommodities production and consumption. So, before we go for a tabular analysis of different welfare components, let us revisit the same old diagram on positive externality to locate the magnitude of the Pigouvian subsidy again. So here, we can say that this gap between these 2 prices PB and PS, which are basically the prices received by the producer and the price paid by the buyer actually gives the magnitude of my Pigouvian subsidy ok.

So now, let us note down the welfare components one by one in this table. So, we will first start with the consumer surplus. So here, the price has gone down. So, as a result consumer surplus will go up to right ok. Now producer surplus will be, note that there will be some externality positive one for the society and this will be now increased because, more quantity is being produced now, but this time the government has to bear the cost of the subsidy program.

So, it will be a negative thing for the government and the volume of subsidy shall be deducted and here is the volume of the subsidy paid by the government to the producer right. So now, if we sum them all, we get the area as the total economic surplus or social welfare ok. Now please compare the welfare that we have obtained in the status quo case

and the welfare after the imposition of the Pigouvian subsidy, note that we have this extra element H plus I compared to the status quo situation.

And this H plus I, if you note the diagram basically that used to give me the dead weight loss area right as marked by rate. So basically, we have increased our social welfare, which were earlier lost because of this problem of non existence of market for the positive externality. So, we are done with our discussions on externality, next we are going to start discussion on some data analysis tools, which are very useful for applied micro economics research work.