Introduction to Environmental Economics

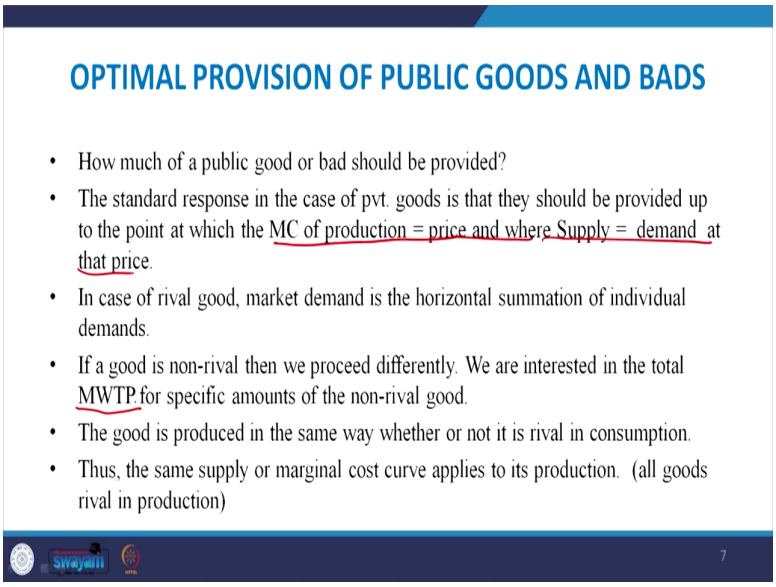
Prof. S. P. Singh
Department of Humanities and Social Sciences
Indian Institute of Technology, Roorkee

Lecture – 44
Optimal Provision of Public Goods and Bads – II

Dear students, in the preceding lecture I introduced the concept of public goods and public bads, and also explained you the main characteristics of public goods and public bads. In this lecture you will study about the Optimum Provision of Public Goods and Bads. There are two kinds of provisions; one is optimum provision and other is the market provision. And here using the rival and non-rival environmental products you will be able to know the market demand and supply curve of these two kinds of products.

And, at the point where supply curve for non-rival and rival products intersect their demand curves equilibrium level of prices determined. So, as far as supply curve is concerned their supply curve is similar; because both rival and non-rival products are rival in production although they are non-rival in consumptions. And by using the indifference curve, I will explain you that how the market provision is different from efficient provision of public goods.

(Refer Slide Time: 02:08)



Let me now discuss optimum provision of public goods and bads. How much of public goods or bads should be provided? So, in fact, in case of private goods our response is that we should provide the public goods sorry, private goods at the point where marginal cost of production is equal to the price and supply is equal to demand at that price. So, this is very important point that, in case of private products marginal costs should be equal to the price of the product and supply and demand should intersect each others and equilibrium level of price may be determined and the market can provide private goods at that point.

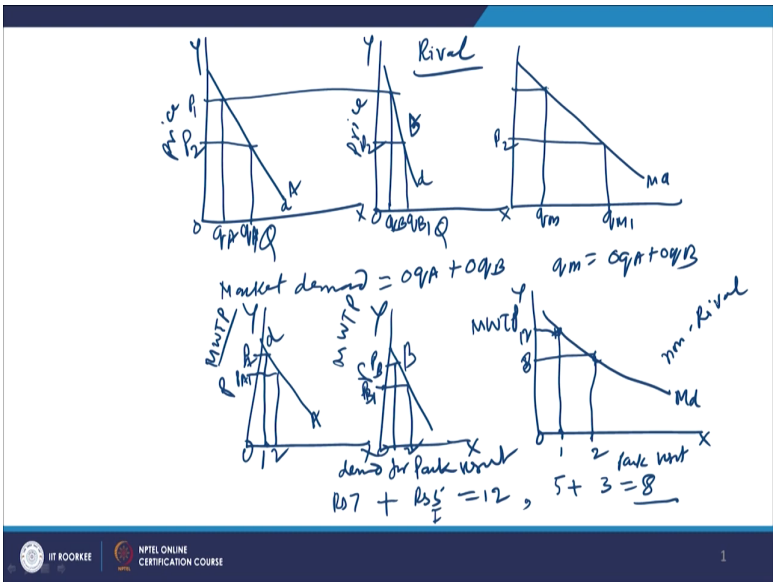
So, in case of rival product, market demand can be estimated by horizontal submission of individual customers demand. If a good is non-rival then we can proceed differently. We are interesting in the total marginal willingness to pay; this is marginal willingness to pay for a specific amount of non-rival product. The good is produce in the same way whether or not it is rival in consumption. Thus, the same supply or marginal cost curve applies to it is

production because all goods are rival in production. So, this is very important let me again explain.

There are two types of goods one is rival product. So, in case of rival product if we wanted to estimate the demand for rival product, the demand can be estimated by making the sum of all individual customers demand and sum is made horizontally. So, the market demand is the horizontal summation of individual customers demand. While in case of non-rival products we have to proceed differently; because here the quantity is not fixed. For example visiting a park how much you are consuming the park quantity cannot be determined, but you can make different visit of the park.

So, how much you are willing to pay for the first visit of the park, how much you are willing to pay for the second visit of the park; for instance, if one person is willing to pay 10 rupees for one visit of the park other is willing to pay 20 rupees for one visit of the park so, in that case the demand will be estimated in terms of how much they are willing to pay. So, 10 plus 20 equal to 30, so, first visit of the park 30 rupees are willing to be paid by the two customers. So, in this way we can estimate the demand curve for non-rival product.

(Refer Slide Time: 05:49)



So, let me now simply discuss you how to draw the demand curve. Suppose we have price is taken on Y axis and Q quantities taking on X axis and if we take a demand for A person this is this demand curve shows the inverse relationship between the price of the product and quantity demanded higher the market price lower will be the demand for the product. So, this is a demand for A person.

Now, B person may had different demand. Take the demand curve for price of the product and demand curve maybe like this, which is more steeper than. So, this is a demand curve for B person demand curve for B person d. Now, if you take the a particular price say if price is OP 1, then quantity demanded is q A and q B. So, now you can see the demand for A is having different elasticity and demand for B is having different elasticity.

Now, if you wanted to make horizontal summation, then in that case market demand is market demand is equal to O q A plus O q B. So, this is the demand made by the A person plus demand made by the B person at the given market price and that will be here. So, in this way

you can see this is our market demand curve M d. So, market demand is horizontal summation and this is market demand qm and qm qm is equal to O q A plus O q B.

Now, if market price goes down, then quantity demanded will increase if price is OP 2 quantity demanded is O q A 1 and quantity demanded in this case will be O q B 1 and then market demand will be P 2, P 2 q M 1. So, this is called horizontal summation of market horizontal summation of individual demand constitute the market demand. So, market demand can easily be estimated if we can make some of individual demand at different market prices. So, obviously, the slope of the market demand would be different from the slope of the individual demand; because different customers demand differently to or they respond differently to the change in the price of the product ok.

So, as far as this is the case of rival product rival. Now, if you take the non-rival product then, demand will be different for instance the demand will be estimated vertically not horizontally and in that case. Suppose we have again this is the demand curve of A person demand of A person we have the demand for B person and price is taken or in place of price we are taking marginal willingness to pay marginal willingness to pay marginal willingness to pay. So, marginal willingness to pay and price both are the same things.

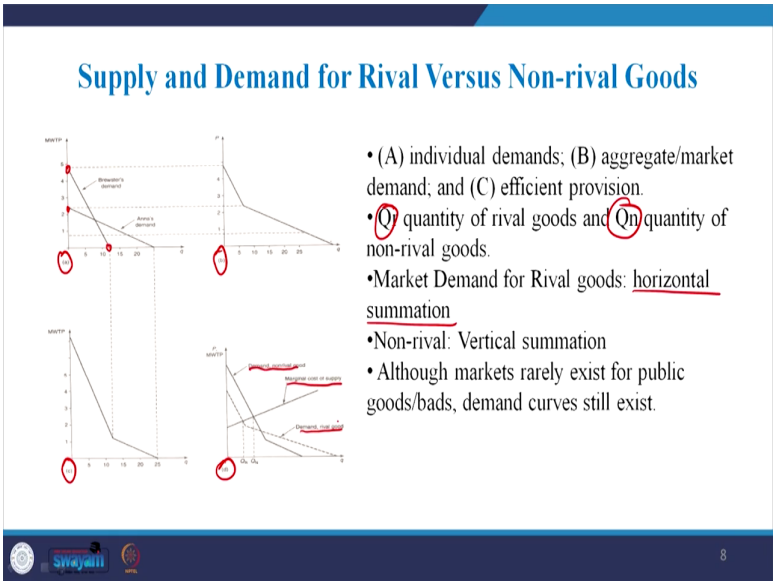
Suppose for one if this is the demand for park visit demand for park visit. So, if a consumer make one visit of the park and is willing to pay this OP price for the same visit B is willing to pay PA, PB price; then market demand will be added horizontally and if another visit is made second visit second visit then you can see PA 1, PB 1. So, now this is another price. So, in that case what you have to do is visit 1, visit 2. So, park visit is taken here park visit and marginal willingness to pay marginal willingness to pay are taken on Y axis.

So, you can estimate the market demand for visit of the park by adding vertically the demand. For example, one visit to a park say consumer A is willing to pay say rupees 7 and consumer B is willing to pay rupees 5 then rupees 7 plus rupees 5 equal to rupees 12. So, rupees 12 is first visit, then second visit this is the first visit. In case of second visit consumer A is willing to pay 5 rupees and consumer B is willing to pay say 3 rupees then 3 plus 5 equal to 8 rupees.

So, 8 rupees is the total. So, now you can see here, this is one point say 12 rupees, then second point 8 rupees 8 rupees.

So, if you draw the curve, then it will be called a demand curve where 8 rupees and 12 rupees for first visit and second visit. So, this is the market demand for non-rival product non-rival product. So, you can easily estimate the market demand for rival and non-rival products.

(Refer Slide Time: 13:46)



So, after understanding this concept, now let me tell you from this graph. In this graph thus I have explained the demand for rival and non-rival product.

So, now in this graph there are four panels; you can see A panel, B panel, C panel, and D panel exactly these are the same things which I discussed earlier. Now, there are two

customers consumers one is say Brewster and other is the Anna's. This is the supply this is the demand curve of first consumer and other is the demand curve for second consumers.

And, now if you look at market price P when market price is 5 the both at 5 the quantity is 0, but as the market price increases ah market price declines and it is. Suppose this is the market price, then this is the quantity this is the quantity demanded by first customer and at the same price they know quantity demanded by you can see first at this point quantity demanded is say horizontally you can add and as you can see when market price is 0.2something quantity demanded is 5; when market price is 1 quantity demanded increases.

So, by adding horizontally, you can get this market demand curve. So, this is the market demand curve which is the horizontal summation of individual customer demand curve and there are only two customer A and B and we make horizontal summation of the demand curve of the two customers to get the aggregate demand curve. So, here A panel indicates the individual demands of the two customers, B indicate aggregate demand or market demand which is estimated by adding the individual demand curve at different market prices. Here Q r is the quantity demanded for rival product r stand for rival and Q r i s rival product and Q n is the non-rival

So, we have the two kinds of products rival product and non-rival products and market demand for rival product is shown by panel B where horizontal summation is made. While non-rival demand non-rival demand is estimated by vertically summing like this margin willingness to pay which I already discussed. For example if customer A is willing to pay 5 rupees for a particular unit and customer B is willing to pay say 4 rupees then 5 plus 4 equal to 9. 9 will be the total marginal willingness to pay for the particular unit.

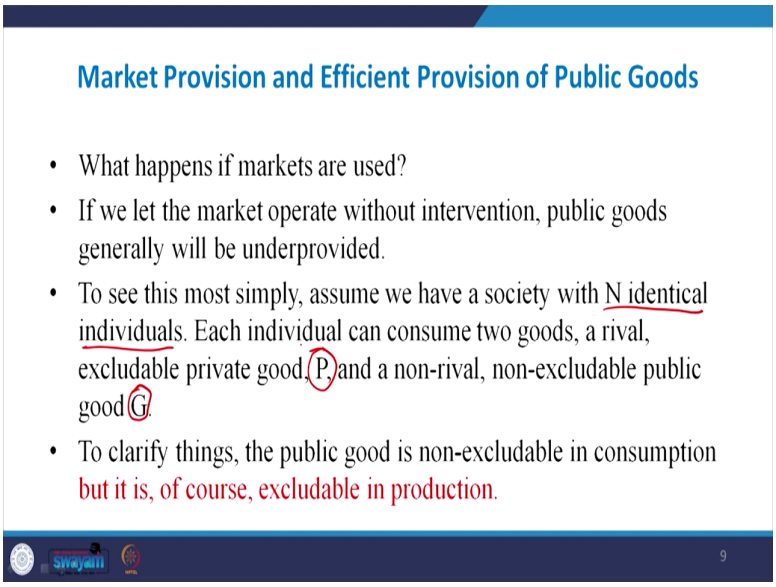
Similarly, if the quantity is increase from say 5 to 10 how much the customer A is willing to pay and how much customer B is willing to pay for the same quantity. So, sum total of that is called aggregate market demand for non-rival product. But, one important things here is, that whether the product is rival or non-rival, they are produced with the resources which are having opportunity cost or they are actually rival. So, all products are rival in production because resources involved in the production of rival or non-rival products are having

competitive uses and they have opportunity cost. So, that is why they face the same supply curve or they face the same marginal cost curve.

So, marginal cost curve also known as supply curve. So, this is the marginal cost curve which is same for both rival demand product and non-rival product. So, here you see in this graph this is the demand for non-rival product and then demand for rival products and equilibrium price is determined at the point where the supply curve is intersecting the demand curve of both the product rival and non-rival product.

And, here you can see that this dotted line either demand curve for the non-rival product rival product and that intersecting the supply curve. And, at this intersection point Q n is the demand for non-rival product and Q r is the demand for rival product. So, when the supply curve is intersecting the non-rival demand curve at a particular point at that point market demand is determined for rival product it is Q r and for non-rival product it is Q n market provision and efficient provision of public goods.

(Refer Slide Time: 20:08)

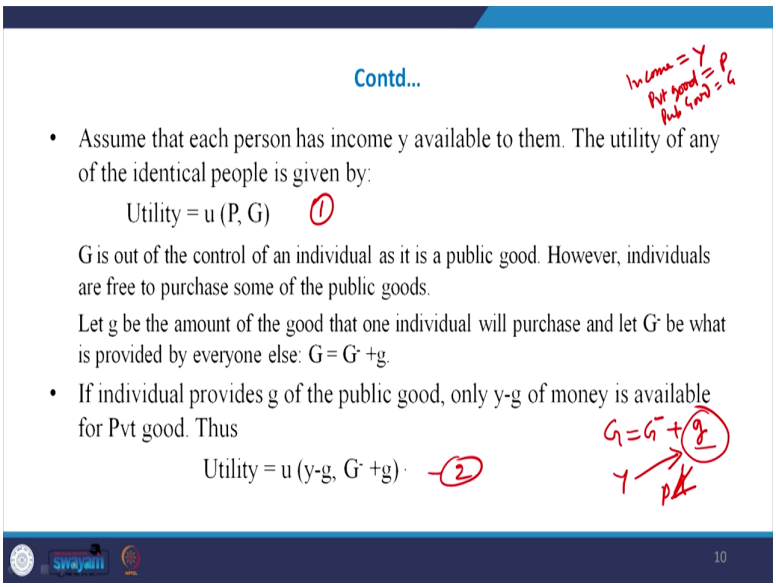


Here what happens if market are used? If we let the market operate without intervention then public goods will generally be under provided. So, our point here is that if they know regulation, if externality is not internalized, then the public goods will be under provided by the market.

To see this most simply assume we have a society with N identical individuals. So, let us visualize a society a small localities where there are N number of members of the society and all are identical. Each individual can consume two products – one rival product say convictional product which is rival as well as excludable private product P and another non-rival product that is non-excludable also and known as G. So, there are two kinds of product being produced and consumed by the society – one is P that is private product and other is the G that is government or public product.

To identify things public goods is non excludable in consumption, but it is of course, excludable in production as I already told you that all products are excludable and rival in production.

(Refer Slide Time: 21:50)



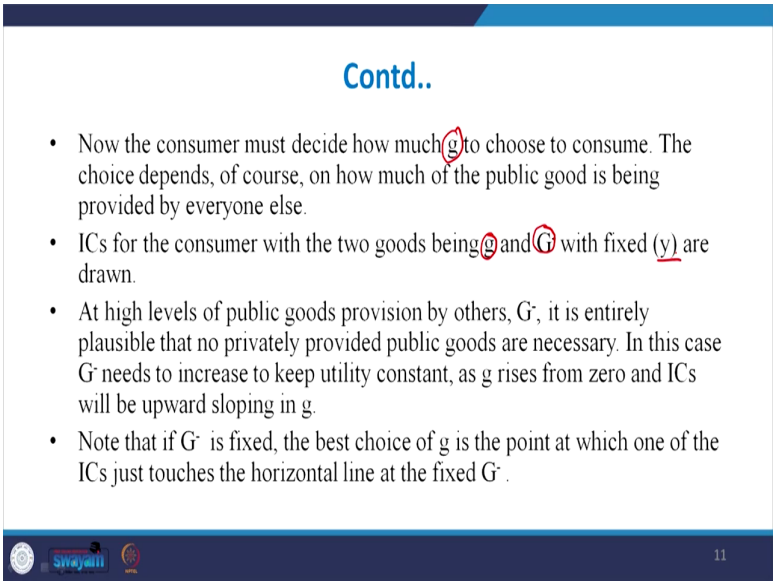
Now, let me take utility of the consumer. Assume that each person has income y. So, income here income is y and there are two products private good is P and public good public good is G. So, we have two goods private goods and public goods, and consumer a limited income y which can be spent on these two products ah. So, utility will be maximized subject to the availability of two product P and G and given the income to be spent on these two product.

So, G as we know is a public good is out of the control of the individual and, but individual can also generate some quantity of public goods by themselves. And, if we divide this G into two categories G is the total public goods; one is G bar and plus small g. So, G bar is the

amount of the public goods which are provided by others and small g is the quantity of public goods, which is created by the individual under consideration. So, therefore, aggregate G is equal to G bar plus small g.

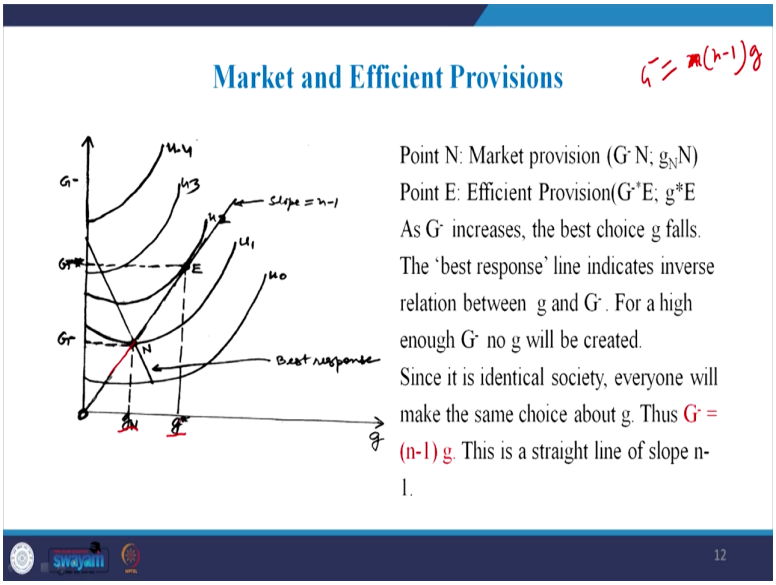
If individual provides g of course, if this g is provided then a part of the income y will be spend on g so, less will be the P. So, less will be the quantity of P. So, quantity of P will reduce when a part of income is diverted towards creating of the g. So, therefore, now this equation 1 for example, can be converted into equation 2 utility is u y minus g because now a part of the income will be spend on consumption or creation of a small g and G bar plus g. So, G bar plus g means aggregate public goods and y minus g means the amount of the money which is spent on P now.

(Refer Slide Time: 24:39)



Now, the consumer must decide how much g to choose how much is small g to choose to consume. The choice depend upon how much the other public good is being provided by others. Here I can explain it with the help of a indifference curve where we are taking two goods – one is a small g and other the G bar and G r with a fixed income y. So, we have small g that is the public goods created by the individual we have G bar provided by others and we have fixed income.

(Refer Slide Time: 25:32)



So, by all these things we can now draw the indifference curves. So, we have a map of indifference curve u 1, u 0, u 1, u 2, u 3, u 4 and here higher the indifference curve higher will be the level of satisfaction. And, on vertical axis we are measuring G bar that is public goods created by others and on horizontal axis, we are measuring a small g that is the private part of

the public goods; means how much individual is creating public goods by spending some part of the income y.

So, in this case actually it is very interesting to look at this graph that if others are providing the public goods, then you do not need to provide your own public good. So, therefore, there is some sort of inverse relationship between a small g and G bar capital G bar means if the G bar increases you will reduce your small g. So, that is called best response line. So, best response line is this is the best response line this clearly shows that consumer individual consumer or individual person will create less small g if others are creating capital G bar or if public goods are created you do not need to spend more money on creating your own small part of the small g or public goods.

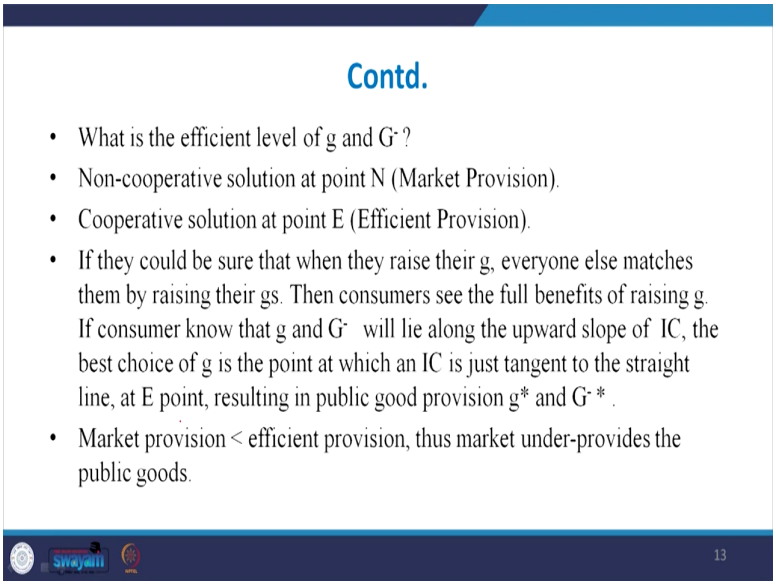
So, in that case the best response line is showing a negative slope. But, at the same time as I already told you that since society and identical, then G bar will be equal to n minus 1 into small g means. Since n is a number of identical members and individual person is creating small g, so, n minus 1 multiplied by g will be the g bar since all members of the society are identical. Now, this n minus 1 g is a straight line you can see here this is a straight line of the slope is n minus 1 and this is straight line is intersecting the best response line at point n and it is tangent to the point E at indifference curve u 2.

So, here there are two important point here at the point where the n minus 1 slope line is intersecting the best response line at the point n market provision is determined. So, market provision for public goods and private goods is small this part g n and G bar and that is because that is at the lower level of public goods G bar as well as a small g because people feel that if others are providing the public goods and since product is non-rival you do not need to create their own G. So, obviously, if they are not cooperating each others, then the market will under provide such kind of product.

But, if everybody corporate each others and then they create a small g's then aggregate public goods will increase and this is clearly indicated at point E. So, at point E is the equilibrium point and at this point you can see the g star a small g star is the is the higher quantity of a small g created by the individual, then the previous quantity that is provided by the market

when there is no cooperation among the them and G bar star is also greater than G bar. This clearly indicate that if all cooperate each others, then the efficient solution will be at higher level of public goods and if they are not cooperating each others then the solution will be at the lower level of output.

(Refer Slide Time: 30:41).



So, in conclusion, we can say that market provision is a lower than the efficient provision and that is why we can conclude I discuss here two points: one is that the market provision of public goods is lesser than the efficient provision. And this can be shown at two different points on the indifference curve at point N; when the individuals in the society are not cooperating each others then the best response line will intersect the n minus 1 slope line at point N.

And, at point N the market provision is determined which is lesser than that is determined at point E where the slope of n minus 1 line is tangent to a higher indifference curve or higher welfare curve. So, in that sense we can conclude that market under provide public goods and market provision is lesser than the optimum provision of public goods.

In next lecture, I will explain or continue from this point. And I will explain externalities and then how to model externalities to internalize externalities to know the efficient allocation of goods with or without externalities in the next lecture.

Thank you very much.