Environmental & Resource Economics
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Optimum extraction of renewable resources and Tragedy of Commons Part – 7

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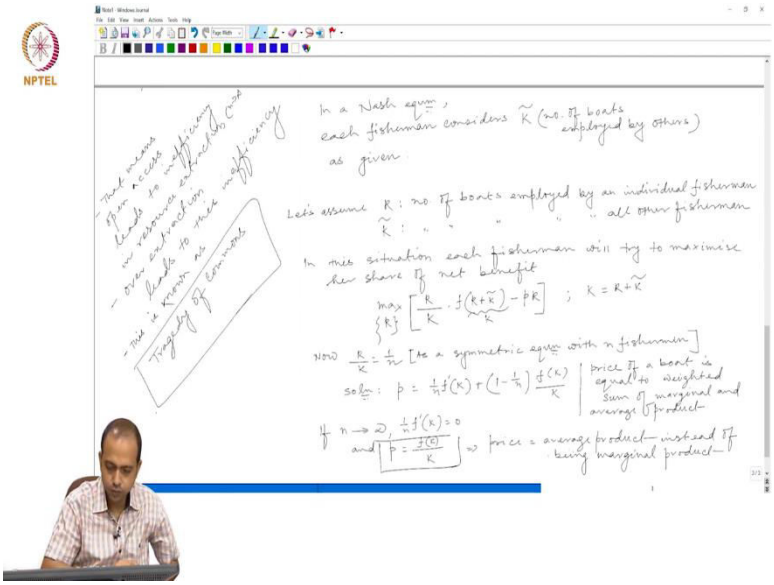

In a Nash situation, each fisherman considers k tilde which is number of boats number of boats employed by others, as given. So, first I considered other's best strategy and then I decided about my best response. So, first I consider k tilde number of boats employed by other fishermen, then I decided about my optimal number of boats. So, considering k tilde I will decide about my number of books.

So, let us assume small k is number of boats employed by an individual fisherman and k tilde is basically number of boats employed by all others, all other fishermen. And in this situation each fishermen will try to maximize her share of net benefit. So that means in terms of a simple optimization model the objective here is to maximize. What is the net benefit?

How it is calculated? Net benefit is calculated by small k divided by capital k into that production function. What is the production function? k plus k tilde. So, this is the production function, and a fraction from that output is enjoyed by the single individual that is given by small k divided by capital k, and minus the price of the boat. This is very simple.

So, this first component basically gives you the revenue. Why revenue because the first part is output multiplied by my share of boats so where small k is the amount of boat. What I have

employed capital K is the total number of boats small k, I should write it, where capital K equals to small k plus k tilde. So, this is basically capital K.

Now, small k divided by capital K equals to actually 1 by n where n is the total number of fishermen. As a symmetric equation with n fisherman. If we assume all fishermen, they are symmetric, they are homogeneous in terms of their size then small k by total k capital K is equal to basically 1 by n.

So, then what is the solution for this maximization? This is the maximization problem. And what is the control variable here? Control variable is basically your number of boats. You might be thinking, why this is number of boats not rate of extraction. Actually, number of boats is directly related to the extraction because I have assumed initially the fish catching is only a single input production function.

So, if that is the case you can control your fish catching by controlling your number of boats employed. So, basically you are trying to maximize this wherein, we are assuming that small k by capital K equals 1 by n, as a symmetric equation with n fisherman. And the solution of this maximization would be p equals to 1 by n into f of k which is capital K, plus 1 by 1 minus n into f of capital K divided by k.

So, that means, basically what I am saying price of a boat p is basically price of a boat, price of a boat is equal to weighted average or weighted sum sorry weighted sum of marginal and average product. If prime K is the marginal product f k divided by k is the average product, and this is the weight. 1 by n is the weight for the marginal product, 1 minus 1 by n is the wait for the average product.

I am basically not showing how this equation is coming because that will come from maximizing this problem considering a Nash equilibrium a strategic kind of situation where everyone decides about others function as given so it is kind of interaction function, we have to introduce so on and so forth without doing much of complication the solution I am directly putting it here. This solution is basically solution of this.

We are trying to maximize this, where control variable is this wherein k tilde is basically given. So, that solution will turn out as p equals to this. Now, if n tends to infinity what will happen? If n stands to infinity, then this 1 by n f prime k this becomes 0, and in that case p equals two then what will happen this is 0 so that means this would be f of k divided by k.

So, this is the price equation. So, that implies price equals to average product instead of being instead of being marginal product. So, p equals to marginal product when that condition is satisfied that is called efficient solution because that is the competitive solution we derived earlier.

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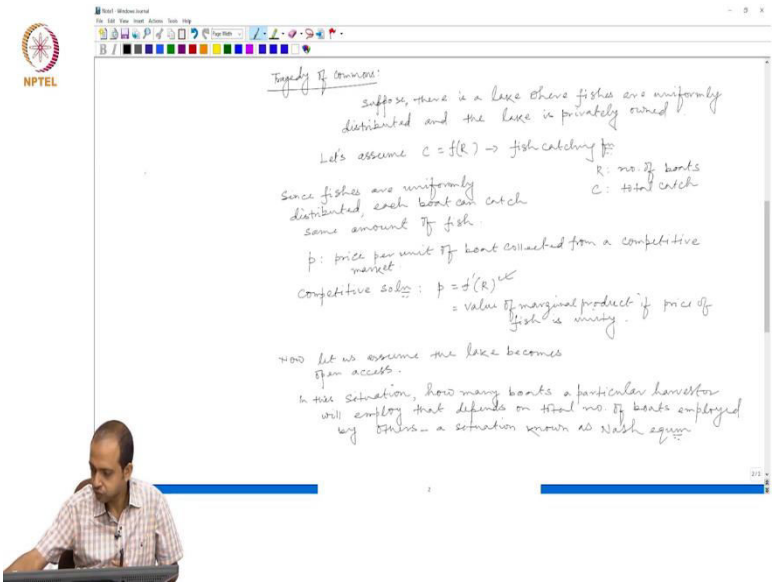

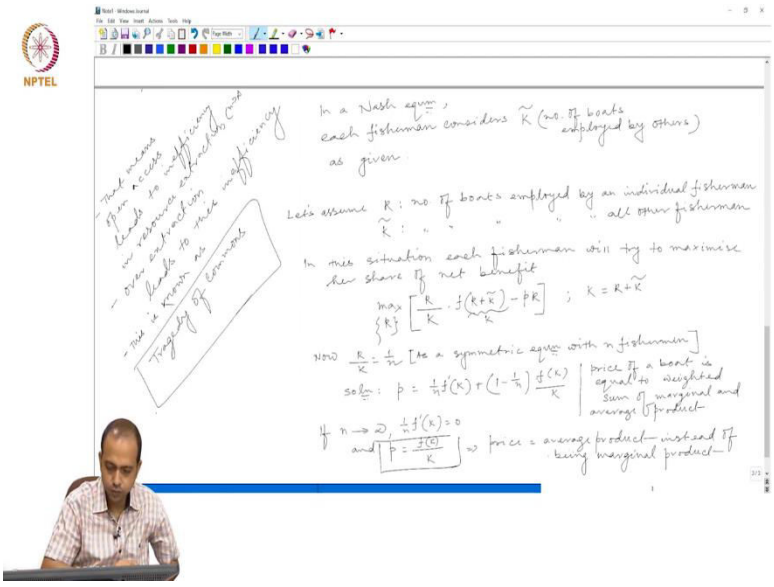

If you go back and see this is the competitive solution p equals to f of k. So, this solution, competitive solution is efficient solution, but here when we assume open access resource p becomes equal f k by k price equals to average product instead of being marginal product. So, that means, there is, that means, open access leads to inefficiency in a resource extraction inefficiencies resource extraction as intense to infinity, inefficiency in resource extraction.

This is, so that means over extraction due to over extraction leads to this inefficiency. So, in our, if you recall, in our previous class what we are discussing with the simple diagram if p is actually equals to average cost then that leads to over extraction instead of being equals to marginal product. And we say that the divergence between marginal cost and average cost is actually the congestion externality.

Here, we are defining price in terms of marginal product, not marginal cost because there we have assumed a fish catch function. Earlier it was a catch locus, which is basically the cost of catch, but the idea is similar. If p equals to marginal cost or p equals to marginal product then we say that the resource is utilized efficiently because that is the solution derived from a competitive situation.

The moment to introduce open access there are too many harvesters. So, number of boats or rate of extraction of a particular fisherman is always decided by keeping other's strategy as given. So, when others are employing too many boats, when others are extracting at a faster rate, it is better for the single individual for the individual fisherman also to increase his or her rate of extraction, and that is what is happening here.

As n tends to infinity p is being equals to, p is equals to f k by k which is average product. So, price equals to average product instead of being marginal product and that means, open access resource leads to inefficiency in resource extraction, over extraction leads to this type of inefficiency and this is known as tragedy of common. Then the next question come, how do you solve this tragedy of commons?

solution to tragedy of commons community-based management or collective action. This is basically suggested by the famous economist Elinor Ostrom, and she got a Nobel Prize also for suggesting this collective action framework for governing the commons, for a better governance in the context of this type of common pool resource was first introduced by Elinor Ostrom, and she got a Nobel Prize in this particular context.

So, what is community-based management? See, the problem of this common pool or open access resource is basically lack of any institutional arrangement, which can actually decide about the rate of extraction. Everyone and anyone is allowed to extract at whatever rate is suitable for a particular harvester. So, lack of institution is the major source of this type of externality in the context of a common pool or open access resource.

Now, sometimes these resources are managed by the local community. The local community what they do, they are basically the local community invest their time and money for managing the resource, that is why, it is called common property resource. So, for managing the resource and the common pool resource becomes a common property resource.

So, this is also denoted by CPR. So, there are two CPRs here actually. One is called common pool resource another one is called common property resource, but we should not get confused with both the CPRs. See, in case of common pool resource, common pool resource is basically a collection of so many open access resources, there is no institutional arrangement, there is no property right well defined, anyone and everyone can enter in resource extraction and that leads to tragedy of commons.

In case of common property resource, the resource is basically owned and managed by the local community, the local community, they own the resource, they define the property right among themselves and they decide about rate of extraction, they manage the resource by investing their time and money. So, the moment it is managed by the local community, then the common pooled resource now become common property resource.

So, community-based management is basically an example of collective action. Local community collectively manage this resource. But that does not mean that community-based management is always successful. Community based management is not always successful. To have a successful community-based management all the individuals belonging to that community must cooperate.

But the cooperation comes when some critical number of individual actually cooperate. So, that again becomes a game theoretic kind of situation. Every individual in the community thinking let others in the community manage the resource, and I will free right. So, that means, there need to be a leader in the community who will ensure the critical number of individuals are actually participating and managing the resource.

So, collective action becomes successful when an individual is convinced that others are also participating and they are not freeriding. Who will convince that? The community leader, there would be a leader in the community who will convince each and every member of the community that others are actually cooperating.

So, community-based management like decentralized governance, because the central planner has less information about the local resources. So, that is why power is given to the local community, and local community they decide about the institutional arrangement, they put their time money and energy for managing this resource and that becomes community-based management, common property resource.

And community-based management becomes successful when each and every individual in that community is convinced that there are others who are also participating. And who will convince that? The community leader will convince that others are also participating. So, in case in case so, community-based management becomes successful when everyone in that community participates in managing the resource.

So, community leader, basically ensures that others are participating, and no one is free riding. In case, community management also based management also fails then what is the solution? Only solution to protect tragedy of commons left is privatization. So, resource would be then owned by a private owner, privatization. But this privatization will have consequence on efficiency and distributional aspect.

Generally, it is assumed that if we privatize the resource then efficiency of resource utilization will go up because that is what we proved. In case of private ownership the price is actually equals to marginal cost or marginal product and that is the competitive solution. So, there is no question about the efficiency of this private ownership or privatization.

But if we think about the distributional aspect, many ports, what will happen, many ports are solely dependent on the common property resource or common pooled resource, whatever. So, privatization will adversely affect their livelihood. So, we need to think about the efficiency and the distributional aspects carefully before privatizing a particular common property resource.

Efficiency will improve, but the distribution or equity concept, the equity will go down because many ports are solely dependent on this type of common pooled or common property resources. That is how, these, keeping these two points in mind we should think about what type of institutional arrangement we must put in place for a better management of the resource, and to prevent the situation to become tragedy of the commons.

And we also know that there are, there is a two-way relationship between poverty and environmental degradation, poverty and environmental degradation. So, manier time the developmental projects they adversely affect many common property resources. For example, if there is a, there is some kind of infrastructure built in a particular forest.

Let us say government of India is thinking about converting a forest a huge area of forestry for constructing an infrastructure let us say a railway, so that will adversely impact the local environment or resource. When the resource is impacted adversely because of this developmental project, what will happen?

The local community they will try to extract is more than more. So, that means, their poverty they are poor, they are trying to extract this resource more and more and as a result of with the resource again gets depleted so fast. So, development and poverty environmental degradation and poverty, they are actually two-way relationship.

Poverty, their level of poverty makes them reliable for reliable on the resources, resource extraction they will extract the resource and that will lead to a situation where less amount of resource available make them even more poor, because the local resource is the only source of their livelihood.

So, poverty makes them reliable only the resource, resource extraction increases, less resource available in turn they become even more poor. And this type of relationship, that means, environmental degradation and poverty this problem get more, becomes more worse in the context when the resource is negatively impacted by any type of developmental project. So, that means, to protect this type of resource from being tragedy of commons, we need to carefully think about the institutional arrangement.

Privatization may lead to a situation where resource becomes efficiently utilized, efficiency may go up, but distributional aspect equity will go down because many poors are fully dependent on these type of local resources for their livelihood. So, with this, we are closing our discussion today. Basically, we learned, what exactly is the tragedy of commons when an individual rationality leads to a situation, which is collectively bad.

And we have also proved with a simple mathematical model, how tragedy of commons is actually is a result of individuals rationality where individual fisherman is trying to maximize his or her own share in that resource utilization. And then to solve that tragedy of common

problem there are the privatization or community-based management these are the two solution we can think of when community-based management is in situation wherein the resources are owned and managed by the local community.

When local community also fails to manage the resource, then privatization becomes the only solution left. And privatization will have impact on efficiency which will improve but equity which is the distributional aspect will go down because poor are dependent on this type of resources, so designing institutional arrangement requires a careful thinking about its impact on the local community. Thank you.