Environmental & Resource Economics
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Introduction to Environmental Economics and Environmental Kuznets Curve Hypothesis
Part- 4

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Module 6: Incentive design

- Price rationing: Charges and subsidies

- Quantity rationing: tradable pollution permits

- Incentive compatibility

- Evaluation criteria: effectiveness, efficiency, equity

- Problems with emission taxation and permit system

And if that is not possible, then in your next module what we are going to discuss is basically how to correct externalities by designing incentives. This bargaining solution is not possible all the times. So, we need to design certain incentives. Why incentive is required? Again going back to the principles of economics, if you recall one of our 10 principles where rational people respond to incentives, rational individuals respond to incentives.

What is incentive? Incentive is not always with a positive connotation that means incentive is not always some award or reward or prize or anything, incentive can also be a punishment. So, we will discuss different types of incentives in this module for correcting externalities. The first incentive, what we are going to discuss is price rationing.

That means, we will discuss emission taxes or subsidies for better clean production or R and D clean, clean R and D. So, we will discuss about emission tax, which was suggested by the British economic Pigouvian taxation. Then we will also discuss about subsidies, which are actually price

rationing. So, that means we are imposing some price either in the form of tax or in the form of subsidies. Then, we will discuss about the limitations of this price subsidies, sorry price rationing, particularly in the context when there is uncertainty.

So, another mechanism by which also economics they suggested to correct externalities is quantity rationing and quantity rationing is basically by tradable pollution permits. So, instead of imposing emission tax on the polluter, what this quantitative rationing suggests, they say that you assign certain tradable permits to the polluters and ask them to trade that means, if somebody is very good in, very efficient in production, less pollution making, then that particular firm will have extra permits with him or her.

And that extra permit the firm can trade with the other firms, which are actually inefficient in their production. So, this tradable pollution permit is just the opposite of, it is an alternative to price rationing. It is called quantity rationing. So, we will first discuss price rationing, next we will discuss about quantity rationing. Then we will discuss about incentive compatibility, incentive compatibility, see when we talk about incentive, we are talking about either subsidies or tax and that is based on the cost of pollution, cost of, sorry, cost of abatement.

If I ask a firm, what is your cost of abatement every firm would tell that cost of abatement is very high, because if they say it is very low, then the policymaker is going to impose more and more regulation, they will say then you will, you should a bit moved. So, they will report their cost of abatement is very high in the, expecting that if they say it is very high regulator will ask only to control less amount of pollution.

Then the regulator that means should design something, so that the private players they will automatically reveal their true cost of pollution or true cost of abatement. So, that means the regulators who design the incentives, which are compatible to the private information, private player knows better than the regulator, what is the actual cost of production and what is the cost of abatement, but they do not reveal that the true information.

So, policymakers challenge is then to design the incentives in such a way that they will reveal their true cost of production and true cost of abatement. So, that is called incentive compatibility.

Once we discuss incentive compatibility, then we will discuss about evaluation criteria of these two mechanisms. We have discussed price rationing, we have also discussed quantity rationing, emission tax these are the tradable pollution parameters.

But then, before imposing a policy, before implementing the tax or subsidies or tradable pollution permit, what do we need to discuss is basically their effectiveness, how effective these emission tax or subsidies or tradable pollution permits would be and how efficient they are and how equitable they are, that means what would be the implication of these policies on equity perspective.

Whether they are effective that means whether the policies that we are going to implement whether they are able to achieve its target, whether it is efficient that means whether they are achieving their target at a minimum cost and then equity that means, it should not favour certain section of our society and it should not punish severely to certain section of our society, that also we need to discuss, then only the policymaker will be in a position to take appropriate policies.

And lastly, we will discuss about the problems of this emission taxation as well as the permit system, problems of price rationing as well as quantity rationing. This is going to be our module 6, where we are going to talk about incentive design based on one of the principle or principles of economics, which says rational people respond to incentives.

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- **Introduction to frontier approach of measuring efficiency**

- **Measuring environmental efficiency**

- **Cost of pollution control**

Then in module 7, what we said that once regulation is imposed, that may hamper the performance of the productive units, then a natural question comes to our mind, then how do we actually measure their performance and one such way is environmental efficiency that means we assume that once regulation is imposed, that may enhance the environmental efficiency of the productive units.

So, here interestingly, we will discuss about the most recent approach, which is called frontier approach of measuring efficiency, particularly, the environmental efficiency and how, what is the impact of regulation on firms efficiency, is it efficiency enhancing or efficiency damping. So, we will introduce measuring efficiency, then we will also understand measurement of environmental efficiency and then cost of pollution control.

That means, as we discussed earlier, why the private players they are not so much interested in pollution control, because there is a cost involved and that costs should not be so high so that it makes the productive units less competitive, because if it is too high, then what will happen the producers also will try to bypass a part of that cost to the customers, to the consumers. Think logically if an emission tax is imposed on a productive, on a polluting firm, then what will happen, cost of production will immediately increase.

If the cost of production increases, obviously, the price of the good will increase. So, that means producer will try to bypass the tax burden, a part of the tax burden on the consumers and we have to suffer, that is why before implementing the regulation, we need to think what is going to be its impact on the cost side, cost of pollution control. Because producers will definitely bypass some part of that cost of pollution control to the consumer to us, how much they will bypass that actually depends on the elasticity of demand.

That means, a relative bargaining power of the producer and the consumer, if the consumers are less elastic or inelastic demand that means they have less bargaining power, producer will bypass a significant portion of that cost of pollution to the customer. If the customers are highly elastic that means they have more bargaining power, then producer they themselves have to be at the cost and it may so happen that because of this imposition of tax the production becomes so less profitable, they may even exceed the market.

So, that is why understanding cost of pollution control is very important, but then how do you measure that? This frontier approach which we will discuss in this module that will make you understand how to measure efficiency of production, how to measure environmental efficiency and then how to measure cost of pollution control. And these cost of pollution control once we estimate that will guide the policymakers whether that amount of tax should be imposed or not or if not tax what should be the appropriate policies, what should be the appropriate policies.

And in this context, we will also discussed, we will also discuss about these are all price rationing, quantity rationing, cost of pollution control, related to price or quantity rationing, see these are all basically, when you, if you think these are all called formal regulation, that means, formally we are imposing taxes, emission taxes.

Now, in the context of developing countries, implementing these cost of pollution, implementing this formal regulation is very difficult, because that requires a high level of monitoring. I am imposing tax, but then policymaker has to ensure that they have a mechanism to monitor who is avoiding the pollution control norm and who is not, who is emitting how much pollution based on which only we can impose tax.

So, monitoring is actually an issue in the context of developing countries where we have less resource, when there are huge number of polluters monitoring all these polluters, who is generating how much pollution and then imposing tax is very difficult. So, that means, formal regulation, they have less success stories in the context of developing countries.

When the formal regulation fails, then informal type of regulation becomes more and more important in this context. And one such important type of informal regulation is information disclosure, what is that, that means, we will disclose the environmental performance of productive units to the public that becomes very useful.

Because, nowadays corporate side also become more and more interested towards corporate social responsibility, CSR and in the era of CSR activities, once this information about their environmental performance is disclosed in public that will create some kind of image for this private business pairs. If they are able to create a green image, then they get the benefit also from that, through the feedback or capital market keeps.

That means customers they value the product, even the shares of those companies which are environmentally responsible. So, therefore, once we discuss, once we complete the discussion of formal regulation we will also discuss about this type of informal regulation in the form of information disclosure and corporate in the context of corporate social responsibility.

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- What is economic value of environment?

- Stated preference approach: contingent valuation and choice experiment

- Revealed preference approach: travel cost method, hedonic price theory

- Production function approach

Then, in module 8, what we are going to discuss is theory and methods of environmental valuation. Now, why do you require environmental valuation or rather we will say that economic valuation of environmental goods and services. Once again if you recall, we said that the main reason for environmental degradation is they are not properly valued, because there is no direct market.

In absence of direct market for these environmental goods and services, generally what we assume that these goods and services are free, there is no price. So, if we think that environmental goods and services are free, what will happen, we will generally tend to overconsume those and that will lead to environmental degradation. Therefore, we need to have a proper price signalling for these goods and services when there is no market.

So, our challenge is then how to create a market, how to create an artificial market for these goods and services through which we can actually estimate the value of environmental goods and services. That is why economic valuation of environmental goods and services become so important. So, we will first try to understand what exactly is the meaning of economic value of environment; then there are different approaches to estimate the value.

One approach is called stated preference approach. That means, we will create a hypothetical market and then we will ask the respondents to state their value. For example, let us say that we

have a forest and we do not know what is the value of this forest, should we preserve the forest as it is or should we deplete, should we cut all these trees and make this forest area useful for some infrastructure building.

And as we said that economist, as an economist, we are not environmentalist, we will not go by sentiment, that trees are always good, we should preserve rather, throughout this course we will follow the neoclassical paradigm of utility maximisation where our idea is, whether tree is good or bad forest is good or bad let the respondent, the stakeholders their state their value towards this; that is the approach.

So, in stated preference approach, we will learn how to create that type of hypothetical market and estimate the value of environmental goods and services through this approach, basically two approaches contingent valuation method and choice experiment. These are the two approaches we are going to learn in stated preference approach.

Then, there is another approach called revealed preference, where customers they have respondents or individuals they have already revealed their preferences for environment. How is that possible? We said that environment does not have any direct market then how is it possible for the respondents to reveal their preference? Yes, it is possible. They reveal their preference for environmental goods and services through a market which is related to environment.

For example, we can think of housing market, same type of house if you take the price of that in a most environment friendly area and in a polluted area, then you will see that price of the same type of house in an environment friendly area is much higher than the other one that means respondents they are ready to pay a premium for better environment.

Because other things are same, same 2 BHK, same square feet, same syllable area, same 2 windows or 1 window, same thing, all other features of that house is same only environmental quality is different and as a result of which there is a difference in the price. And that price is basically the premium that the respondents are giving for the environmental quality that is called

revealed preference approach. In this revealed preference approach, we will discuss about travel cost method and hedonic price theory.

And lastly, we will discuss our production function approach where environmental goods and services will enter as an input in the production function. We will estimate the production function and then we will see what is the value of environmental goods and services. So, in all these approaches our objective is only to get a proper price for these environmental goods and services. So, up to now, that means up to module 8, what we have discussed is actually 50 percent of the course, in the course title what I said environmental and resource economics. So, that means, you can say up to module 8 this is all about environmental economics mostly.

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Module 9: Optimal extraction of renewable and non-renewable resources

Then in module 9, we are going to discuss only optimal extraction of renewable and non-renewable resources, then you might be thinking, we have discussed so many modules for 50 percent and this module that just one module for another 50 percent, why this is so? Yes, this is so, because, here we are going to talk about optimal extraction of renewable and non-renewable resources. And when you talk about optimal extraction, what does it mean?

That means, we should not extract the resources too rapidly or too slowly. But how do you ensure then optimal extraction? That required when we, this is a typical problem of utility

maximisation in a dynamic setup. That means, suppose, we have certain barrels of oil how much, how many barrels of oil that we do not know, let us say 100 barrels of oil and that we are going to use for the next 10, 15, 20 or 50 years.
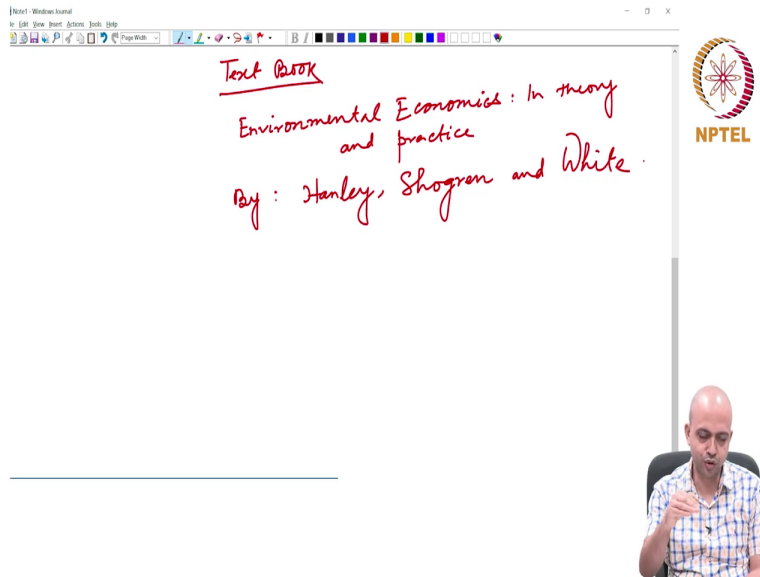
That means, here our objective is to decide optimal extraction that means, optimal extraction at each time period not only a single period that will give, so that the some of the utilities is actually maximum. So, it is not a static framework, it is a dynamic setup, which requires dynamic optimization or dynamic programming. Now, this dynamic optimization control theory or dynamic programming we have not yet learned.

In this course only I will introduce the dynamic programming in a very lucid manner so that you can understand how to maximise utility in a inter-temporal framework. That means, this is not a one shot game, where I have some amount of resource what we are going to use now itself, I have a resource that we are going to use for the remaining 10, 15, 20 years and how will you ensure how much litre of oil to extract in period 1, period 2, period 3, like that in Tth period.

So, that means we need to determine a price path because as I said price will only tell you how much to extract, how much to sell. Since, this is a price we need to determine for each and every period, it is not P rather it is PT, P at a particular time period that is why it is called a price path, optimal price path that will lead to optimal extraction path and that would be discussed that way you will understand by dynamic optimization or dynamic programming.

So, you will get a training of dynamic programming also in this course; that is why this one module itself is remaining 50 percent. So, this is going to be our entire syllabus. What we are going to discuss one by one; we will follow the textbook.

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Let me write it down the textbook for this, the title is Environmental Economics: In theory and Practice by Henley, Nick Henley, Shogren and White. This is a textbook. Apart from this textbook, we will be using several journal articles and that those journal articles references for those articles I will be referring from time to time as and when it is required. This is going to be your textbook. So, you can try getting a soft copy of this book.

Hanley, Shogren and White Environmental Economics: In Theory and Practice and journal articles I will give you the link, you can easily download that. With this we are closing our discussion today and tomorrow we will discuss about our module number 3, where we are going to discuss the impact of economic growth on environment by the EKC approach. So, next class we will discuss about Environmental Kuznets Curve. Thank you!