Environmental and Resource Economics
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Policy Implications of Environmental Kuznets Curve and Economics of Sustainable Development part – 5

So, welcome once again to our discussion on sustainable development, we were discussing about sustainable development and yesterday, we said that economist they define sustainability in two different ways one is called outcome based approach.

Where we assume that utility should be non declining or consumption should be non-declining over a period of time and if that is ensured then we can ensure sustainable development also and second approach is called means based approach or factor of production based approach, where to ensure sustainability, we must ensure that means of production or factors of production should be stock of factors of production should be known declining over a period of time.

Before we come back to today's discussion, I would like to mention as minor corrections in notation. So, what I use the study for non-declining utility non-declining consumption or non-declining factors of production, what I mentioned yesterday is simply Ut greater than equals to 0 that is actually not Ut.

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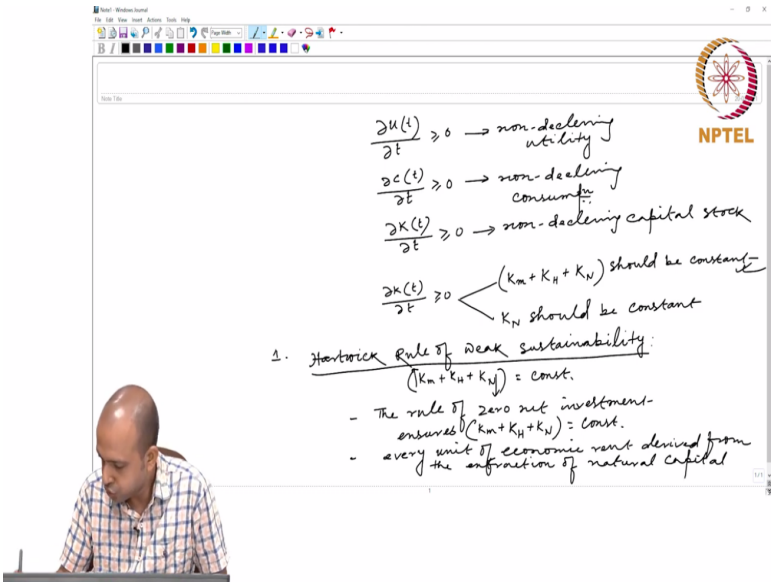

So, that should be delta Ut delta t greater than equals to 0, because without using this differentiation, we cannot measure actually the change. So, this implies non declining utility and this implies non-declining consumption, non-declining consumption and this probably, if we denote capital stock by Kt then del Kt del t this implies non-declining capital stock.

So, this is a minor correction I would like to make and then we said that, depending on how do you we ensure capital stock to be non-declining or constant we will get two different rules of sustainability, we said that this can be ensured by del Kt, del t non-declining capital stock it has two different approaches, the first one it says that all the three forms of capital that means K Km manmade capital, then KH human capital and KN natural capital should be constant, should be non declining or constant also, non-declining or constant I would say and the other approaches said the natural capital should be, should be constant.

So, depending on which approach we take, we will get two different rules of sustainability and today, we will take both the rules. So, when we take the first one, the first approach is called when I say the stock of three forms of capital here if you look at I have omitted that social capital though it is also an important form of capital because of the measurement difficulty. We have omitted the social capital here, we are considering only manmade, human and natural capital.

When we say that Km plus KH and plus KN should be constant or non declining, then that is basically called Hartwick rule of weak sustainability which says that Km plus KH plus KN should be equals to constant. This is called Hartwick rule of weak sustainability. So, that means the implication is according to this rule in the process of economic growth or development, any one form of capital may go down.

So, that means, the stock of natural capital may go down that is absolutely no problem as long as we can replace KN by KH or Km. Now, the question is, so that means, this can go down, in case we are able to increase the stock of manmade capital. But how do we ensure that, that when KN natural capital stock is going down, then manmade capital is going up basically Hartwick says this particular rule of 0 net investment ensure, ensure Km plus KH plus KN equals to constant.

For example, every unit of economic rent, what we derive from the extraction of natural resource should be reinvested fully into the man made capital. So, that when the stock of natural resource natural capital goes down, we will get an additional or equivalent amount of manmade capital to work with that is the idea. So, every unit of economic rent derived from the extraction of natural capital should be reinvested in manmade capital.

So, as to get an equivalent amount of manmade capital where natural stock of natural capital goes down. What is economic rent here? So, basically it says every unit, every unit of economic rent derived from the extraction of natural capital

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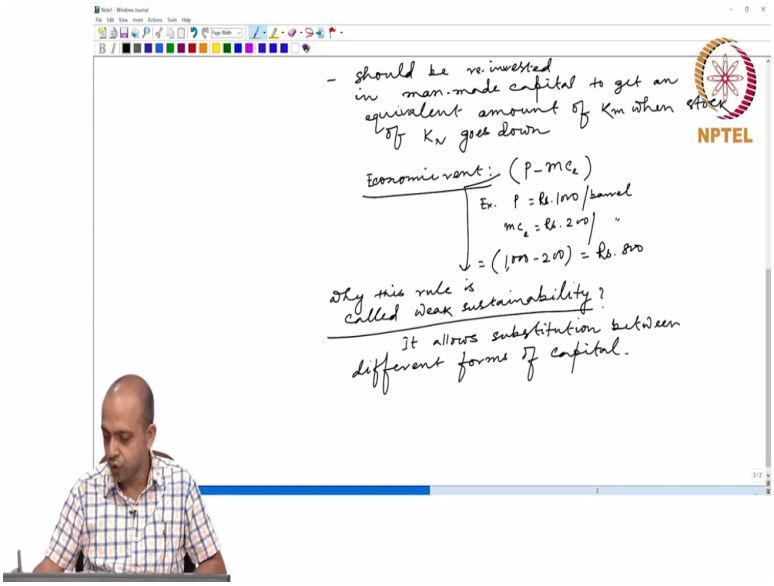

should be reinvested in manmade capital to get an equivalent amount of Km, when stock of KN goes down, that is the idea. Now, what is the rent here, economic rent? Economic rent is defined as the price of the natural resource minus its cost drop, marginal cost of extraction that is, that is basically the economic rent. For example, when we extract one barrel of oil, if market price of the oil is 1000 rupees and cost of extraction.

So, cost of extraction for example, if the P equals to 1000 rupees per barrel and mc extraction is let us say 200, then economic rent equals to, so this said that economic rent equals to 1000 minus

200 equals to rupees 800, this is the economic rent difference between price and marginal cost of extraction and these 800 rupees should be reinvested in any other form of manmade capital.

So, that when the stock of oil goes down, then that manmade capital will give equivalent amount of services that we are deriving from oil that is idea. So, this is called, this is called Hartwick rule of week sustainability. Even though Hartwick rule of week sustainability that is quite appealing because first of all, why this is called weak sustainability?

This is called weak sustainability because it allows substitution between different forms of capital and that is the reason this Hartwick rule of sustainability, this is called weak version of sustainability.

Now, there are as I said, even though Hartwick rule of weak sustainability is quite appealing as it allows substitution between different forms of capital and it does not impose any stringent restriction that yes, we must always keep natural capital to be constant, it has several limitations for its practical implication. So, we need to understand now, what are the limitations of weak sustainability as proposed by Hartwick.

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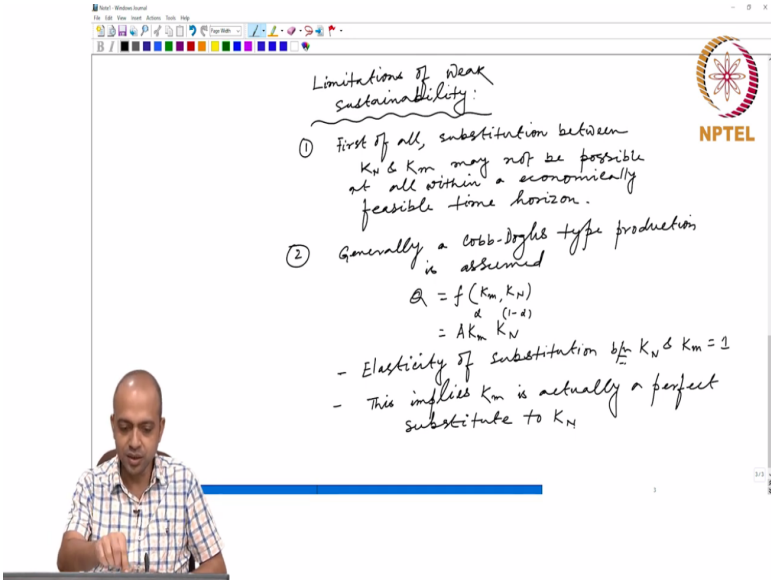

So, what are the limitations of weak sustainability? There are several limitations of this weak version of sustainable development. So, let us try to understand one by one. First of all, KN and Km that means natural capital and manmade capital may not be possible at all.

Even though this weaker version of sustainable development it says that Km and KN they are substitute to each other that means, we can always replace Km, we can always replace KN with additional amount of Km in reality it may not be possible. For example, when stock of oil goes down, stock of coal goes down, then it may not be possible to get an exact amount of duplication or equivalent of manmade capital and that to within an economically feasible time period that is also very important.

So, substitution between KN and Km may not be possible at all within a economically feasible time horizon. Why I am saying economically feasible time horizon? Maybe that substitution is possible after 1000, 2000 or 3000 years, we will get additional amount of coal, oil or something else, but that may not be possible within economically feasible time for within a near future.

So, that is why we say that, what we assumed in Hartwick's rule that Km and KN they are actually substitute to each other that is why we kept KN plus Km plus KH constant that is actually not possible in reality. Secondly, when we think about substitution possibility between Km and KN generally it is assumed a Cobb Douglas type production function.

What is Cobb Douglas production function? That means, output is actually a function of let us say Km and KN where it is assumed that Km to the power alpha and KN to the power 1 minus alpha. This is a CD type production function and if this is the case, then we what we know that elasticity of substitution for this type of production function, between KN and Km equals to actually 1.

So, you can go back and check from your microeconomics, what is the concept of elasticity of substitution and then you can calculate elasticity of substitution for this Cobb Douglas type production function, which Hartwick assumed in the context of weak sustainable development and you will see that elasticity of substitution is actually 1. Now, what is the implication of elasticity of substitution being 1.

The implication implies Km and Km is actually, Km is actually a perfect substitute to KN. So, that means this rule not only allows substitution possibility between manmade and natural capital, it also assumes by the way of assuming a Cobb Douglas production function that man made capital is a perfect substitute for natural capital.

Yes to some extent maybe it is possible that we can get some amount of manmade capital by replacing natural capital, but how can we ensure that manmade capital would be a proper substitute or perfect substitute for natural capital, which is quite unrealistic, but that is what is assumed by the Cobb Douglas type production function assumption in the context of Hartwick sustainable rule. So, these are the, this is limitation number two.