Environmental & Resource Economics
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Introduction to Environmental Economics and Environmental Kuznets Curve Hypothesis
Part- 6

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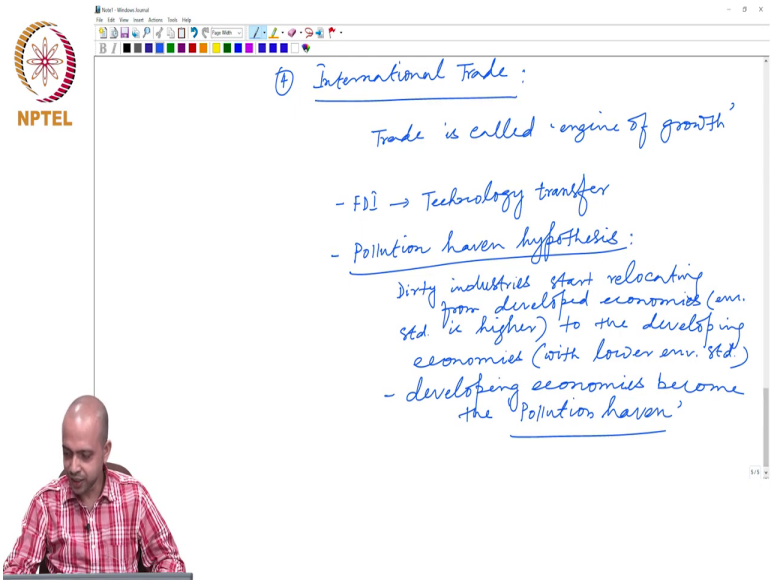

Then thirdly this is fourth explanation that we give through international trade. Now, how international trade can actually explains the EKC type of relationship between emission and income per capita, can you think of, what is the rule of international trade here. Now, if you recall that trade is generally assumed an engine of growth.

We all have studied in development economics, trade is actually, trade is called engine of growth, that means, trade is one of the important channels by which economy grows, this is what we all know from our principles of economy, trade helps economy to grow. Now, as economy grows again the same skill composition and technological effect what we have studied just now, what we have discussed just now, will be applicable by a trade also.

Because trade is an engine of growth so that means trade will help economy to grow. And as the economy start growing, we will have the scale, composition and technological effect of economic growth. So, in that way, international trade will also explain the inverted u shape

relationship between income per capita and emission per capita. This is clear. But international trade, through international trade, there are two other channels by which also we can explain this EKC type of relationship. First of all, through trade, we all know that FDI comes to the economy.

What is FDI? FDI is basically foreign direct investment that is coming to the economy through trade as the economic opening up through trade this FDI will happen and through FDI what generally happens something called technology transfer, that means, that developed nations will invest to the developing nations, developing economies through this FDI and when the developed economies coming to invest in developing economies, then they will also bring with them advanced cleaner technologies.

So, that means technology transfer happens from developed nations to the developing nations through FDI as a result of which the pollution level of these developing economies that improves. So, that means FDI or more specifically, technology transferred through international trade can explain how at a higher level of income pollution per capita comes down for this developing nations.

But, there are other group of economists who says that FDI or technology transfer what we generally think as pollution reducing for the developing economies, it may not be like that, it can be pollution enhancing also for these developing or less developed economies. That is why they say that there is something called pollution heaven hypothesis.

Pollution heaven hypothesis, what is that? Developing nations, if we compare the developing nations and developed nations, generally it is assumed what we experience what we observed that developing economies since the environment is not a priority for the developing countries, because they need to have more income, they need to have more growth to alleviate poverty and to improve their standard of living, they cannot afford of implementing stricter or stringent environmental regulation.

On the other hand developed nations; since they have already achieved certain per capita level of income, environmental standard is quite a high in those economies. Now, what happens when through trade then, those developed economies they try to relocate their dirty industries into

these developing nations. So, that means dirty industries start relocating from developed economies where the environmental standard is higher to the developing economies with lower environmental standards.

So, that means dirty industries start relocating from developed economies to the developing economies and as a result of which what happens developing economies become the pollution heaven. So, that means, at a higher level of income, when the developed nations they start relocating the dirty industries to the developing economies because this developing economies their environmental standard is low these developing economies become a pollution heaven.

So, pollution also shifts from the high income developed nation to the low income developing nations. So, that means this pollution heaven hypothesis can also explain how at a higher level of income pollution basically comes down for the high income economies. So, these are the different channels these are the different explanations given for Environmental Kuznets Curve.

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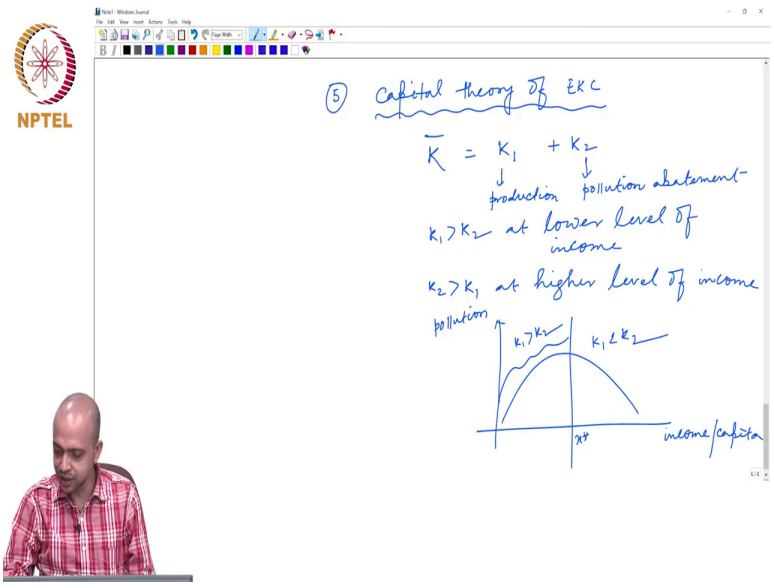

Then, another important explanation or the economics they keep that is the capital theory explanation of EKC, this is called capital theory of EKC. This is the theoretical framework you can think of about the Environmental Kuznets Curve. Let us, assume that the economy is endowed with a fixed amount of capital, which is K bar and this fixed amount of capital can be

used either for production let us say this is used for production and k2 this is also fixed amount which is used for pollution abatement.

Now, at the initial stages of growth, when the economy just started their growth process, what happens since environment is not the priority, economy allocates more capital towards production and less towards the pollution abatement. So, that means, we can say that k1 is basically higher than k2 at lower level of income, at lower level of income since, the priority is given more on production of goods and services economy allocates more capital, larger fraction of the given capital towards the production because the return from the production is much higher than the marginal return from pollution abatement.

This is purely coming from the preferences that the society or the economy places at lower and higher level of income, is this clear? So, that means, we can say that at lower level of income, what happens economy places more important for production and more capital is invested for production less is given for pollution abatement.

And at a higher level of income, what happens when the economy achieves certain per capita level of income at higher level of income when the people demand for more environment friendly products, when people care more for the environment, then k2 is actually becomes greater than k1 at a higher level of income.

So, that means what we can say in the EKC if we draw at this segment k1 is basically greater than k2 more capital is allocated for production that means, we get more pollution as the economy is growing. If more and more capital is allocated for production purposes, less capital is allocated for the pollution abatement obviously, pollution per capita will grow faster than income per capita, pollution and that higher level of income when people start caring about environment then more capital is allocated for pollution abatement less is for production.

Because the return marginal return from pollution abatement is higher at a higher level of income which is very true because environment is after all a luxury goods. So, our preferences society's preference economic preference it changes from lower level of income to higher level of income,

while at the lower level of income preference is given more towards production of goods and services at a higher level of income preference is given more towards pollution abatement.

As a result of which at the initial stages k1 is greater than k2 at the higher level of income k2 is greater than k1 and this capital theory basically explains the inverted U shape relationship between pollution per capita and income per capita. It all depends on how much capital we are allocating for production, how much capital actually we are allocating for pollution abatement.

How much we are allocating for here how much we are allocating for there that basically explained the Environmental Kuznets Curve. So, up to now, what we explain is basically we have provided several explanations for Environmental Kuznets Curve. Now, the next what we need to understand as we said that economist this particular discipline economists they will not only hypothesise something they will also test whether that type of hypothesis is valid in reality or not.

So, far we have hypothesise a relationship, but our hypothesis may or may not be true. We have hypothesised that relationship between emission per capita and income per capita to the inverted U shape, but in the reality what exactly is the type of relationship that we need to understand. For that we need to actually estimate the relationship between pollution per capita and income per capita applying some statistical model.

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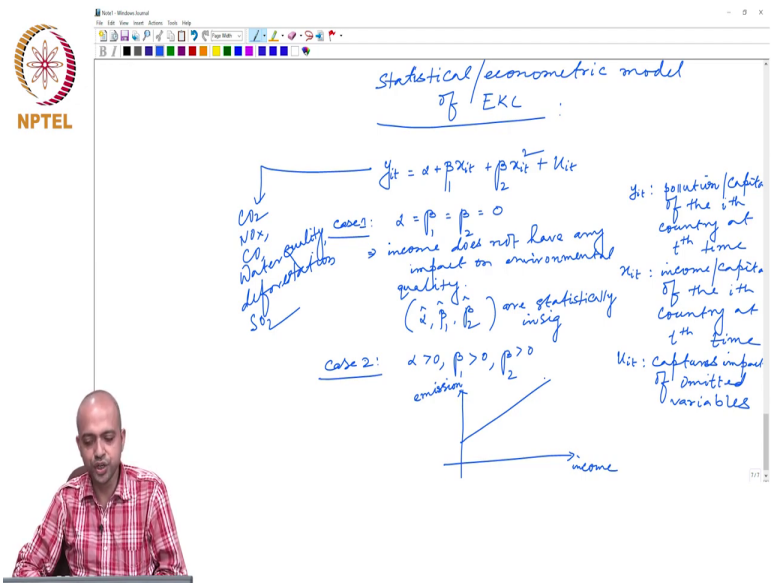

Let us, now think about let us now discuss how the economists they formulate how the economy for how the economists they formulate the statistical model for EKC. So, this is called statistical or econometrics model of EKC. What is the meaning of econometrics, because econometrics is basically the measurement of economics? What is the measurement of economics? Basically measuring the empirical validity of economic theory.

So, far we have hypothesised a relationship now this is the time to check the validity of that hypothesis in an empirical world that is what the economists they do, they will first hypothesise a relationship, then they will collect data and they will fit a statistical or econometric model and then they will test that. Now, we will discuss how to go about this. So, the first step of the statistical modelling is writing a mathematical equation for this Environmental Kuznets Curve.

And the mathematical model is like these yit equals to alpha plus beta 1 xit plus beta 2 xit square, what is yi here yit is basically pollution per capita of the ith country at tth time period and what is xit xit is income per capita of the ith country at tth time. Now, this relationship is called a mathematical relationship, why this is mathematical relationship because if you know income of the country, you can actually exactly predict the emission of the country.

But in reality, it is not possible because emission of a country is determined not only by the income, but also several other factors. That is why economists what they do, they convert this

mathematical model into a statistical one by adding a stochastic error term uit they add a stochastic error term this error term basically captures this uit it captures impact of omitted variables.

So, this is the relationship now, this is a generalised relationship between income and emission. EKC is basically a particular case of this generalised mathematical or statistical model depending on what particular sign we are assuming for the parameters alpha beta 1 and beta 2. For example, if we assume that let us say case 1, what do we assume that alpha equals to beta 1 equals to beta 2 they all are 0 if that is the case, then what we will say that income does not have any impact on environmental quality.

Now, you might be thinking how can this alpha beta 1 and beta 2 could be 0 actually they may not be exactly 0, but after estimating this model and estimation is also possible through statistical software's I will show you in a later part of our discussion how to estimate this type of model once you estimate you will get the estimated value of this population parameter that means, you will get alpha hat you will get beta 1 hat and you will get beta 2 hat.

So, it might so happen that they are actually statistically insignificant, that means in that case we our inference should be that income does not have any significant impact on the environmental quality or emission and this emission it can be CO2, it can be NOx, it can be CO or it can be some other indicators to denote environmental quality like water quality, it can be used by deforestation several other factors. It can be SO2 several factors.

So, environmental quality basically yit though we measured pollution per capita it is basically a generalised concept denoted by it denotes environmental quality and environmental quality is measured by either emission per capita or water quality or deforestation or access to safe drinking water so on and so forth. So, case 1 if this is the case, then we can say that income does not have any impact on the consumption sorry, income does not have any income impact on emission, then case 2. We can say that alpha is positive beta 1 is positive beta 2 is also positive.

So, what will happen in that case in that case if you plot income here and emission there please keep in mind this is always per capita every time I may not be using the per capita word but this

is always per capita when alpha hat alpha greater than 0 beta 1 greater than 0 beta 2 greater than 0 and we will get these type of monotonically increasing relationship. So, that means as income increases, emission per capita also increases monotonically, is that correct. As income increases emission also increases monotonically, this is also not inverted U shape.

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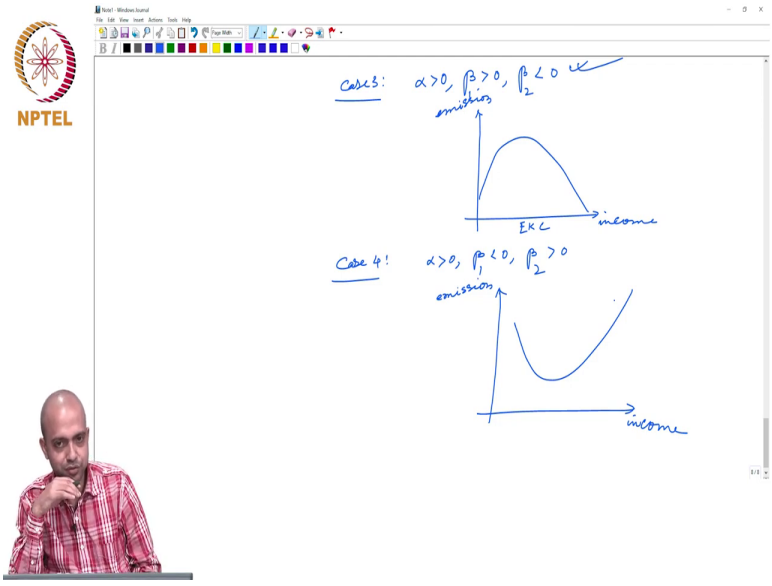

Then case 3 alpha greater than 0 beta 1 greater than 0, but beta 2 less than 0 and they all are statistically significant then what happens we get this type of relationship beta 1 greater than 0 this is income this is emission beta 1 greater than 0, but beta 2 is less than 0 that is why this is inverted U shape, case 4 so, here only we get EKC.

So, that means, you have to understand that EKC is only a particular case depending on what type of sign restriction we are imposing actually after estimation what would be the sign and significance on alpha beta 1 and beta 2 that will tell you either we will get EKC or not there is no guarantee that always we will get this case.

We may get other cases like let us say case 4, where alpha greater than 0 beta 1 is actually less than 0, but beta 2 is greater than 0 then what will happen we will get this type of relationship U shape relationship beta 1 is less than 0 but beta 2 is greater than 0. So, that means as income

increases pollution per capita starts falling initially and then it goes up. So, after estimation we may get even this concept also.

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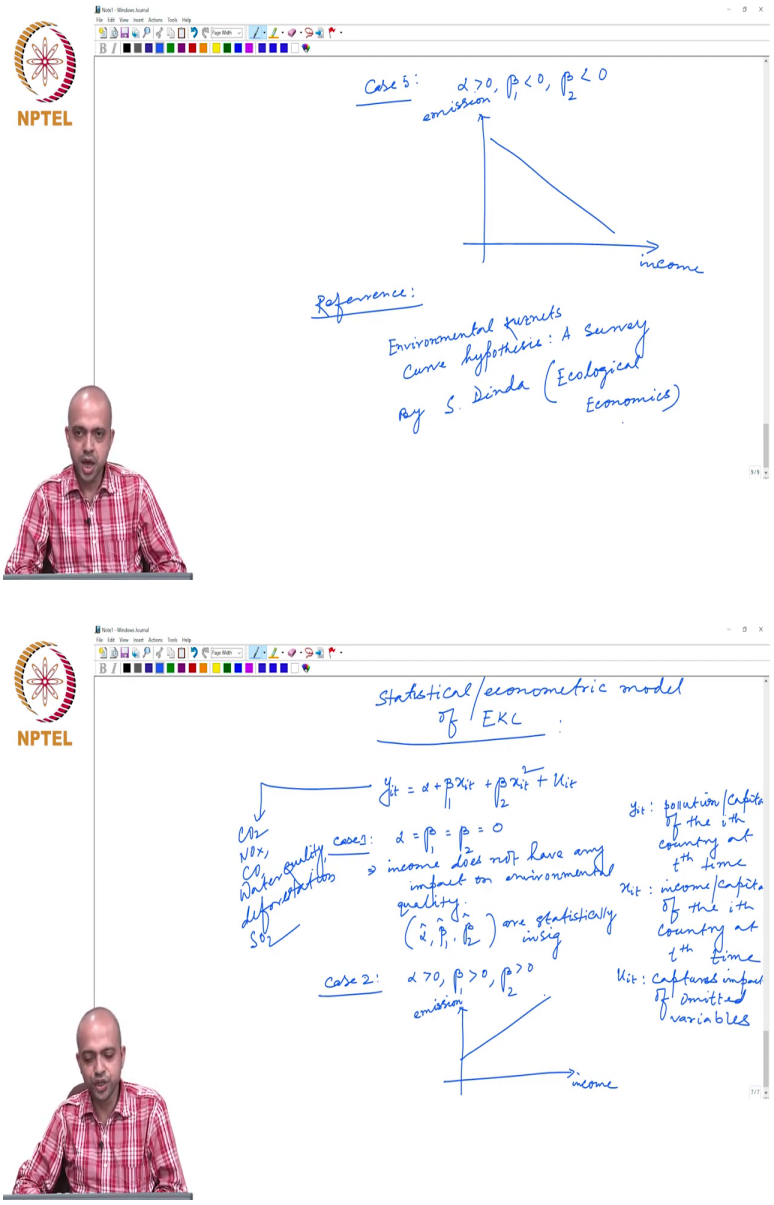

Then case 5 alpha greater than 0 beta 1 is less than 0, beta 2 is actually less than 0 both are negative then what will happen this is income this is emission. So, we will get this type of relationship monotonically decreasing as income increases pollution per capita starts falling and falling this is called monotonically decreasing relationship.

So, that means, depending on your situation, depending on what type of indicator you are using for to measure environmental quality, what type of country you are taking in your sample. By the way, one thing you have to keep in mind that this is yit that means ith country's income emission at tth time period and we can combine all the countries developing countries developed countries less developed countries in the sample and we can estimate this type of relationship.

So, generally it is assumed that we are estimating this type of relationship in a pooled sample where all the economies are combined in a single group in that group we have countries with different level of per capita income, very low per capita income medium high per capita income and also their pollution level also is different.

So, that means, out of these we have discussed 5 cases and after estimation, any of these 5 cases may emerge from your statistical modelling that means, we may or may not get a EKC type of relationship between income per capita and the emission per capita there is no guarantee that I will always get that type of relationship, there is no guarantee.

So, we see from here that if and only if this is the case 3 is the case for EKC and other four cases is actually not supported by the EKC hypothesis. So, depending on which particular case will emerge we have to either reject or do not reject our hypothesis. We can establish our claim depending on which particular case we are getting.

So, this portion that means, today we have discussed about several explanations for Environmental Kuznets Curve and then we have also discussed about empirical estimation how to do the empirical estimation of course, exact estimation I will show you in a later part of our discussion using the statistical software, but so far at least we know what type of econometric model we have to fit in for estimating this.

And the reference for this would be you have to read this particular module from a particular journal article. The reference I will be mentioning this is not given in a textbook a survey Environmental Kuznets Curve hypothesis a survey by S. Dinda and this is from a journal called ecological economics.

So, if you type this title itself in Google, immediately you will get the link for this article and then you can easily download that. So you have to follow this article for this particular module. You will see that in the article they have discussed in detail about many things, but in the class, we have not discussed all those things. I am just trying to give you an outline of this discussion for your convenience.

So, you first watch this video and then if you download that article, then your understanding will be much more clear, with this, we are closing our discussion today. And next day, we will discuss about the limitations and policy implications of this Environmental Kuznets Curve. Thank you.