International Economics

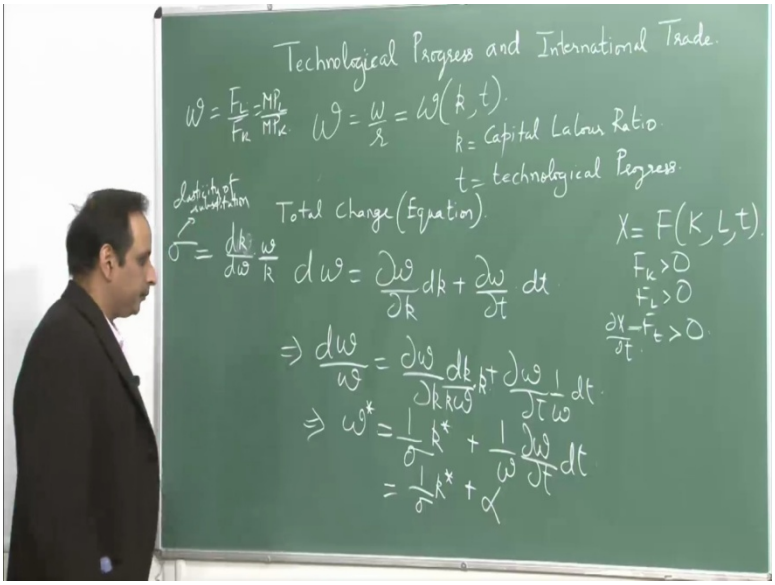
Prof. S. K. Mathur

Department of Humanities and Social Science

Indian Institute of Technology, Kanpur

Lecture No. #32

(Refer Slide Time: 00:30)



Good afternoon. Today, we are going to talk about the technological progress, and its relation with international trade. Technological progress is defined here as as a phenomena, where, where in you, the form uses less amount of labour, and capital to produce the same level of output. Now, when a firm uses less labour and capital, it mean, that the marginal productivities of capital and labour increases. Now, if the increase in marginal productivity of labour is equivalent to the increase in marginal productivity of capital, then you define this as the hicks neutral technological progress. If the increase in marginal productivity of capital is greater than the increase in marginal productivity of labour, then you call this as capital using technological progress or capital deepening technological progress.

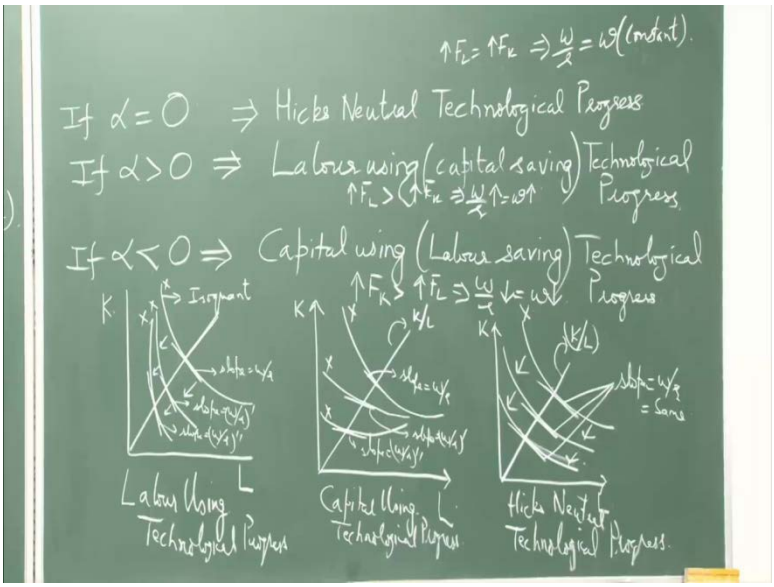
If the marginal productivity of labour increases at an amount greater than the increase in the marginal productivity of capital, then you call this technological progresses alabour using technological progress. So, I will try to model this technological progress by

defining all the three different types of technological progress. Hicks neutral technological progress, labour using technological progress, capital using technological progress. So, you have omega, which is the W by r ratio, this is a function of the capital labour ratio and technology, this is the capital labour ratio, t is the technological progress. And so, you have X. The marginal productivities all greater than 0, where F t is del X del t greater than zero.

Now, this omega is a function of K and t because we saw that, if the capital labour ratio changes then, it would mean changes in the relative wage rates and if technological progress happens then, it would lead to less amount of use of labour and capital leading to increase in the marginal productivities of capital and labour and therefore, having an impact on omega, omega is W by r. And we saw at equilibrium, omega is equal to F L by F K, where F L is the marginal productivity of labour and F K is the marginal productivity of capital. So, the total change equation is d omega del omega del K d K plus del omega del t dt. This is equal to.

So, this is omega star. Now, this term can be written as del W by del K into K by W. Now, please recall that the elasticity of substitution is d K by d omega into omega by k. So, this term would be one by sigma and K star, this is the proportional proportionate change in the capital labour ratio plus one by omega del W del t dt . So further, this is one by sigma K star plus, now calls this as alpha.

(Refer Slide Time: 07:09)



Now, if alpha is equal to 0, this is called the Hicks neutral technological progress. If lambda is greater than 0, then you have the labour using, which is the capital saving. If lambda is less than 0, you have the capital using, labour saving.

Now see, remember this omega is equal to marginal productivity of labour by marginal productivity of capital. So, if the increase in marginal productivity of labour is equal to the increase in marginal productivity of capital, there will be no change in omega. When there is no change in omega, del omega del t would be equal to zero. So, alpha is equal to 0, this is called the hicks neutral technological progress. Inherent in this is that the increase in F L is equal to the increase in F K. As a result, W by r ratio or omega remains constant. This is hicks neutral technological progress.

Labour using technological progress means, that the increase in F L is greater than the increase in F K, this implies that W by r ratio goes up, which is equal to omega going up. If omega goes up del W by del t, you see this to be greater than 0. So, you have labour using technological progress. If the increase in F K is greater than the increase in F L, this would imply W by r ratio going down or omega going down. This is called the capital using technological progress, where del W by del t would be this, you would see that alpha would be less than equal to 0. So, this is how you define technological progress in trade and micro economics. Now, you can always make a diagram, if this is labour, this is K, this is an (( )), you have to draw a straight line from from the origin implying that the capital labour ratio remains the same. Because, remember when you differentiate omega with respect to t, you keep the capital labour ratio constant.

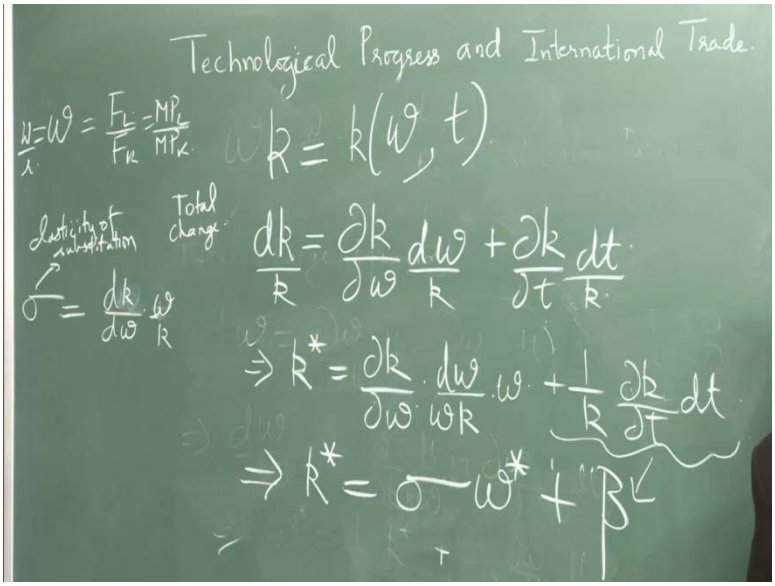
So, if you see an increase (No audio from 11:18 to 13:46). Now, you can see the distinction between labour using, capital using and hicks neutral technological progress. In the hicks neutral technological progress, at the same capital labour ratio, this remains same the slope remains the same. So, technological progress is taking place, that is with less number of capital and labour you are producing the same level of output. This output remains the same. This is X, this is X, this is X , this is X, this is X, this is x.

So now, with less number of capital and labour you are producing the same level of output. But, Hicks neutral technological progress is that, when you use less number of capitals and labour marginal productivity increase, is the same for capital and labour. So, increase in F L is equal to increase in F F K, W by r ratio remains the same. You can see

that you have these parallels are isoquant, W by r ratio remains the same. If, the W by r ratio goes down, it is called the capital using technological progress with the same capital labour ratio. If the W by r ratio goes up, it is called the labour using technological progress or the capital saving technological progress. You can see here, that the slope increases. So, increase in m P L is greater than the increase in m P K. So, that is how you define the technological progress.

Now, there is another way to define technological progress, here you had made an assumption, when you were defining this alpha term, that there is no change in the capital labour ratio. Because, the term that we got here, assumes that the capital labour ratio remains the same.

(Refer Slide Time: 16:09)

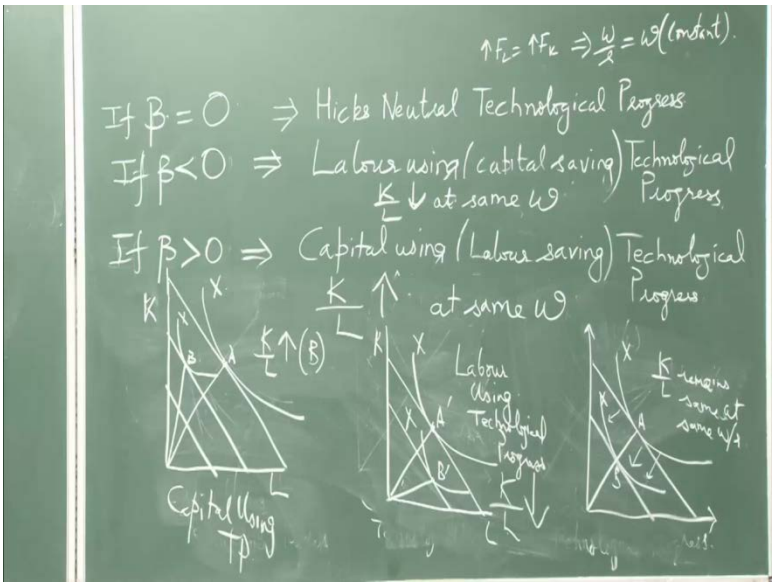


Now, let us define technological progress in another way. Wherein, you write capital labour ratio as a function of omega, and technology. So, if the W by r ratio, which is omega, if that changes that tends to change the capital labour ratio. And technological progress also tends to have an impact on the capital labour ratio keeping the W by r ratio same.

So again, the total change in K is equal to del K by del omega d omega plus del K del t dt. Now, divide by K throughout. So, this becomes K star. Now, this is del K del omega d omega K, you can write it as omega into omega plus one by K del K del t dt. So, this

implies K star to the equal to sigma elasticity of substitution, which is del K del W W K sigma omega star plus beta. We call beta to be this term.

(Refer Slide Time: 18:30)



Now, if beta is equal to 0, it is called the Hicks neutral technological progress. If beta is greater than 0, then it is called the capital using or the labour saving technological progress. In this case, K by L ratio increases at same omega and here, if B is less than zero, you have the labour using technological progress. In here, the capital labour ratio declines at same omega.

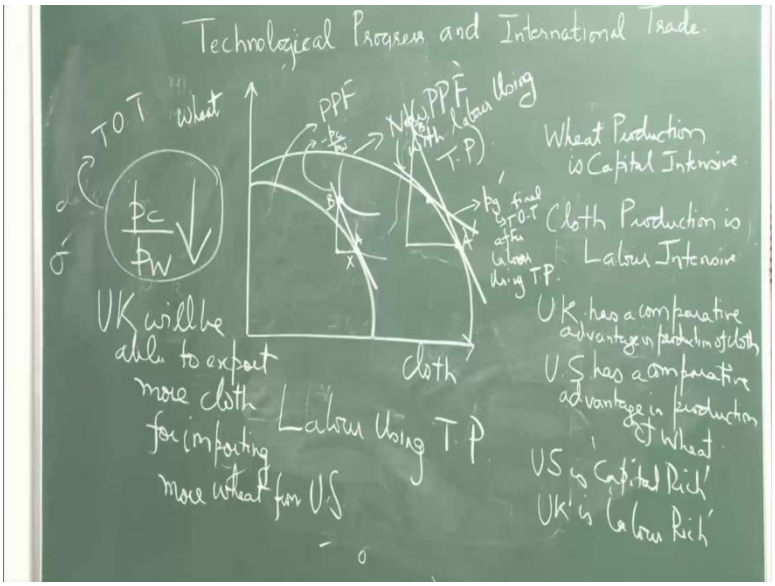
Now, if you have to show it through the figure, again you have capital and labour, you have the isoquant X. Technological progress means, that you can produce X at with less number of capital with less capital and less labour. So then, W by r ratio is the same, the only difference is that the capital labour ratio goes up at point B, it is K by L is greater than K by L at point A. This is called the capital using technological progress. Capital saving technological progress, you will see K L (No audio from 20:27 to 21:03). Here, the capital labour ratio goes down. labour using means, labour deepening process, more of labour is used. So, K by L ratio remains the same. What is to be noticed is that, this W by r ratio remains the same. In the earlier diagram, we had assumed K to be same. Here, we are we are assuming that omega W by r ratio remains the same.

So, labour using means K by L ratio goes down and then the hicks neutral technological progress (No audio from 21:41 to 22:10) the K by L ratio remains the same at same W

by r. So, you can define technological progress, when the relative wage rates are same and you can define technological progress, when the capital labour ratio remains the same. But, the distinction is that, there there are three types of technological progress, which are defined in the literature, which is Hicks neutral labour using, the other is the capital using.

Now, given this given or understanding of the technological progress, now we need to see how technological progress have an impact on international trade. So for this, I would make a diagram showing the production possibility frontier of a country and then we will introduce technological progress in the model.

(Refer Slide Time: 23:20)



So, let us assume that, there are two commodities. One is wheat, the other is cloth. Wheat production is little capital intensive, this is an assumption. While, cloth production is labour intensive. There are two countries one is the united kingdom, the other is the united states. UK has a comparative advantage in production of cloth while, U S has a comparative advantage production of wheat. UK is labour rich, US is capital rich.

So, US is capital rich, UK is labour rich. This is the situation before trade taking place, before technological progress taking place. So, I will draw the PPF, this is the PPF. So, you this country is say say at point A at autarky, it is exporting this much of cloth exporting this much of cloth importing this much of wheat is exporting this much of cloth, importing this much of wheat, it is reached a point like B, it is on the higher in

difference curve than the point at autarky. So, with trade, if it trades then, it reaches a point like B.

Now, assume that technological progress takes place. Now, there can be three types of technological progress. One can be capital using technological progress. Other can be labour using technological progress. The third can be Hicks neutral technological progress. What is the feature of these three, hicks neutral technological progress the increase in marginal productivity of labour is equal to the increase in marginal productivity of capital. So, the W by r ratio remains the same. Or you can say that the capital labour ratio remains the same at the same W by r. You have labour using technological progress defined in two ways. Here, capital labour ratio declines at same W by r, or the increase in m P L is greater than the increase in m P k.

So, as a result, W by r increases at the same capital labour ratio. Capital using technological progress means, capital labour ratio increases, there is capital deepening or the W by r ratio goes down because, the increase in m P K is greater than the increase in m P L. This is the situation of trade taking place between US and UK. US has a comparative advantage in production of wheat. So, it would export wheat. UK has a comparative advantage in production of cloth. So, UK would export cloth. This is the depiction of such trade taking place in the united kingdom. UK exporting this much of cloth, importing this much of wheat. Now, let us assume that, something happens that, something is technological progress, technological progress is labour using technological progress labour using technological progress.

Now, what it would do is, that it would give a Philip to the production of the labour intensive product, which is cloth. So, see what happens with labour using technological progress, there is a shift of the production possibility frontier, but the shape now looks like this. where wherein the wherein, you would see that this shape is more oriented towards the production of cloth. Reason being that, this is labour using technological, progress L by K ratio has gone up, the marginal productivity of labour is greater than the marginal productivity of capital W by r ratio goes up. As a result, this will be the shape of the PPF of the united kingdom. So, this is the old PPF, this is the new PPF with labour using labour using technological progress.

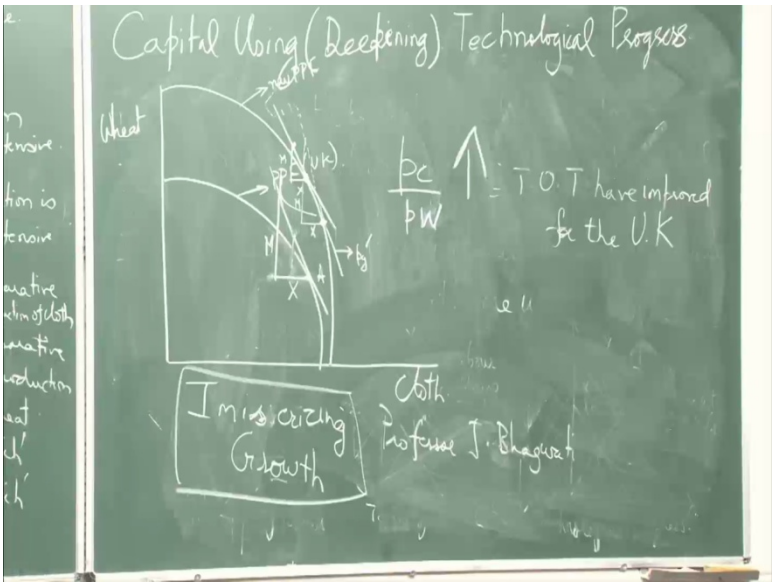
Now see, how prices get effected. With this, if you have to assume the same relative wage rates, the there lative prices, the slope the slope is minus price of cloth by price of wheat. If, after the technological progress, you would have assumed the same relative prices then, you would have exported this much of cloth, imported this much of wheat and you would have reached a point like this. So, you would have moved from A dash to B dash. But, if this needs to happen; that means, if you need to export more of cloth and more of wheat, that is only possible if, the price of cloth by price of wheat goes down. Then only UK will be able to export more cloth for importing more wheat.

So, this is the result, which is not possible. If you if you assume that, labour using technological progress has taken place and the PPF has shifted to the right and there is more production of cloth. It would lead to a decline in price of cloth. So, the terms of trade goes down, then only it is possible for U K to export more of cloth and import more of wheat. So then, the final the final terms of trade this is the final terms of trade this is the final terms of trade after labour using labour using technological progress. Please recall that, when you are talking of the production possibility, frontier if you move from left to right, the slope of the PPF goes up.

So, here you see a fall in the terms of trade, if there is a labour using technological progress. So, UK being labour rich saw a technological progress taking place of the type, which is labour deepening. Leading to a fall in the terms of trade, remember the terms of trade, it is price of exports by price of imports. The export good is the cloth, imported good for the united kingdom is the wheat. So, terms of trade fall for the UK, the terms of trade increases for the US.

So think, in a real situation, in a in an economy like India, if it is labour rich and if you see a technological progress happening in of the type which is labour deepening. It would tend to depress the prices of the goods in which, you have a comparative advantage. So, sometimes there is a talk that the growth should be oriented towards the sector in which, you do not have a comparative advantage. Now, we will see what happens, if there is a technological progress taking place, which is of the type capital deepening, capital using. Because in this case, the terms of trade have gone down.

(Refer Slide Time: 34:22)



Now, you have a capital using or deepening you have a capital using or deepening technological progress So, again you have you have cloth, you have wheat, you have the old PPF or united kingdom PPF of UK. You were here at point A exporting this much of cloth, importing this much of say you are here exporting this much of cloth, importing this much of wheat. This is the trade situation before technological progress taking place. Now, the technological progress takes place, but it is now capital using technological progress. Capital using technological progress means, that the increase in m P K is greater than the increase in m P L. Or the capital labour ratio increases at the same relative wage rates. Whatever it be, the new PPF will be more tilted towards the production of wheat reason being that, it is a capital using technological progress, more capital is used. So, when more capital is used, more wheat will be produced. Because, wheat is a capital intensive product.

Now, if this is UK, technological progress takes place leading to an increase in the commodity in which, it does not have a comparative advantage. So, this is the new PPF . So, at the same relative prices, you are exporting this much, you are importing this much. You are exporting less of cloth, importing less of wheat. Now, this is only possible, if the terms of trade goes up. So, with the capital using technological progress, you would see that the final production would be here, the this is the new slope, country would export more of cloth of more of cloth sorry less of cloth less of cloth and less of wheat. Because, the relative prices the terms of trade have improved for the united kingdom.

So, you see that with an increase, with the capital using technological progress, the terms of trade for the united kingdom improves. Because, that is the only way that UK can export less of cloth and import less of wheat from the united states. So then, the what are the policy implications, that if the technological progress takes place such that, the commodity in which, the country does not have a comparative advantage gets effected, then you will see an improvement in the terms of trade. But if, technological progress takes place in the commodity and if the technological progress takes place such that, the commodity in which, you have a comparative advantage gets effected, you will see a fall in terms of trade.

So, there is very famous theory proposed by a professor Jagdish bhagwati, about the immiserizing growth immiserizinggrowth. This is a term which was coined by professor bhagwati, the famous international economist of the Indian origin, working in the US at the Howard. Now, what he was talking about was something similar to what we are discussed in this diagram. So, if the growth happens in the economy, but it is more tilted towards the product in which, you have a comparative advantage. You would see at the end that the terms of trade would fall for that particular commodity.

So then, point is that, the growth should be such that it should bring equal returns for every one, the terms of trade should improve. So, then there was an argument, that the growth should be such that the growth should be oriented towards the sector in which, you do not have a comparative advantage. And for that, for a country like India, if that had needs to happen, then you need to bring in capital from abroad technology from abroad. So, that you can focus on the commodity in which, you do not have a comparative advantage. Because, that is the way that you can improve your terms of trade.

So, this. So, today we saw the definition of technological progress and wherein we defined three different types of technological progress. One, the hicks neutral technological progress. The other was the, labour using technological progress and the third was the, capital using technological progress. And then, we brought in international trade and we saw that, that if the labour using technological progress takes place, then you would see a fall in the terms of trade for the country, which has a comparative advantage in the production of labour intensive product. While, if there is a capital use in technological progress, we will see an improvement in terms of trade for the country,

which has a comparative advantage in the production of labour intensive product and a comparative disadvantage in the production of the capital intensive product.

So, tomorrow we will see, further we will we will now come back to our model, where we have the structure of production in autarky, and we will discuss the proof of the Stolper samuelson, and the (( )) theorems. And then, as I said yesterday also, we are interested in finding out the relative prices, how relative prices are determined in an economy before trade. Because, that is how you define the relative prices, and opportunity cost of producing a product. Thank you so muc.