Petroleum Economics and Management
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Module - 07
Petroleum Discoveries and Structural Changes
Lecture - 34
Theoretical Framework - II

Hi everyone. I am Dr. Anwesha Aditya, your instructor for the NPTEL course Petroleum Economics and Management. So, we are in module 7 of our course, where we are discussing Petroleum Discoveries and Structural Changes. In lecture number 34 of our course, we are going to elaborate on the theoretical model.

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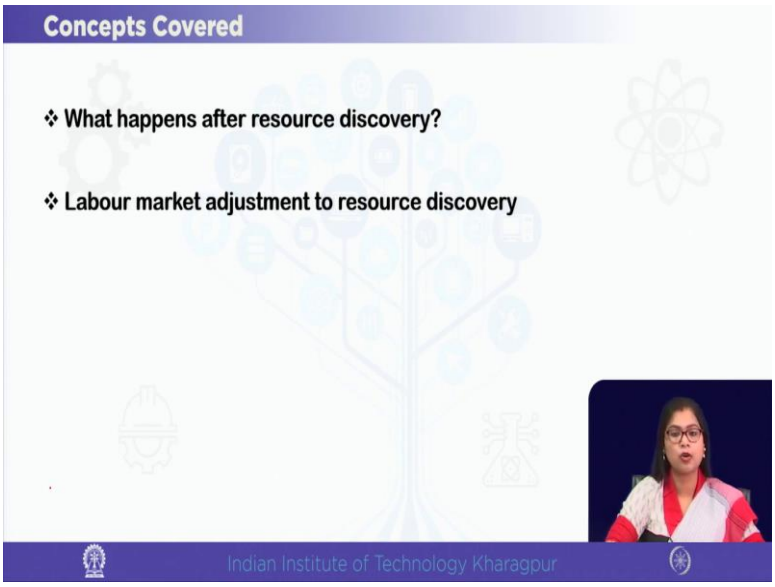

So, if you remember in module 7, we are discussing the phenomena of Dutch disease and resource curse. So, we have already discussed the definitions and how they happen, when there is a sudden discovery of natural resource. Then, we have also devoted some lectures in this module to learn some basic concepts of economics like the some basic understanding of theory of production, the laws of production. We defined a PPF, we discussed about the shape of PPF and finally, we also derived the labour demand curve.

And in one of the lecture, we also started discussing about the theoretical framework because we are going to study a theoretical model to see what happens if there is a

sudden discovery of natural resource in an economy. So, that may not be petroleum only or any type of natural resource, if it is suddenly discovered how the domestic economy adjust what happens after resource discovery.

So, in the previous lecture, we have already discussed, we have set up our theoretical model, we have constructed the framework, we have discussed the assumptions and the implications of the model. And we have represented the model in terms of the PPF, the Production Possibility Frontier and also we have shown the initial equilibrium of the two sector economy in terms of the labour demand curve.

Now, in today's class, we are going to discuss what will happen to the economy in terms of the production possibility frontier after a resource is discovered. And then, we will show in the second part of our lecture, how the labour market will adjust after resource discovery and how the possibility of a Dutch disease arises. And finally, we will give answer to the Dutch disease is permanent or not, whether it can be cured or not.

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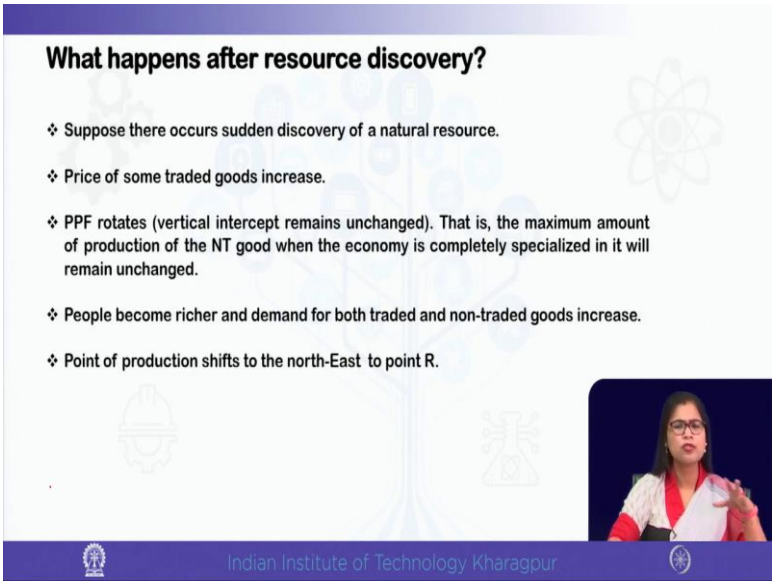

So, just to give you a very brief recapitulation, we consider a two sector economy, the traded sector and the non-traded sector. So, we are clubbing all the goods in which we have the possibility of getting engaged into transaction with the rest of the world. So, we are considering all such traded and non-traded, sorry all such exported and imported goods under the traded sector represented by sector T and the sectors in which we cannot

engage into transaction with the rest of the world. So, those are considered under the non-traded sector, ok.

And we consider a perfect competition, and we consider labour as the variable factor, and capital as the fixed factor. So, we describe the domestic economy before the discovery of the resource. Now, the main implication of these two sector economy is that in the traded sector, the price of the final goods and services, those are determined outside the domestic economy.

In the non-traded sector, the price is determined within the domestic economy. So, if there is a demand side shock or supply side shock inside the domestic economy, the domestic producers of the non-traded good they can respond. But the domestic producers of the non-traded good cannot respond.

Suppose, wage rate increases, then the domestic producers of the non-traded good can increase the price if cost of production increases when domestic wage increases. But the producers of the traded good cannot do that because the price of the traded good is determined outside the domestic economy. So, this was the main implication of this two sector model.

Now, let us discuss what will happen when resources discovered suddenly. Like, we have already discussed the phenomenon of Dutch disease, what happens when natural gas was discovered in Netherlands, and that was basically with reference to Netherlands, the name Dutch disease came up.

And then we also discussed what happened to Saudi Arabia and even in today's, in this particular module in one of the lecture we will also explored some country evidences regarding Dutch disease and resource curse. But let us first complete our theoretical model. So, what will happen if there is a sudden discovery of a natural resource?

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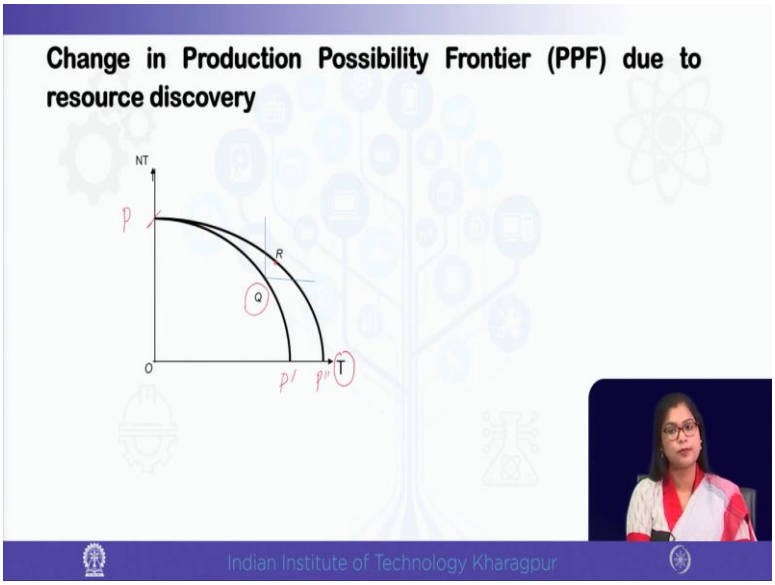

Now, you see as we have already discussed with respect to Saudi Arabia, when oil was discovered, there was a very less domestic demand of oil in the domestic economy. So, what Saudi Arabia did? It found that there was huge demand for oil in the world market. So, they started exporting oil and they become rich overnight, right. So, that means, this resource when it is discovered, it will come under the traded sector, ok. So, this is the first thing..

So, now, if there is a discovery of resource, what will happen? The PPF will change, but you see that will not be a parallel change. Why? Because in the non-traded sector, the vertical intercept of this PPF will not change. Why? If you remember in the previous lecture, we have already interpreted the two intercept.

So, in the vertical intercept means, what is the maximum possible amount of producing the non-traded good given that all the resources are devoted in the production of the traded good. And there is no change in the maximum possible amount of production of the non-traded good, if suddenly a resource is discovered because the discovered resource will be traded. So, that is why it will come under the traded good.

So, therefore, the PPF will change, but without altering the vertical intercept. That means, only the horizontal intercept will get elongated. Why? Because the maximum possible limit of producing the traded good will now expand because the resource will

now come under the traded sector. So, the traded sector will expand. So, the PPF will rotate outward, but it will not shift. So, this is the first step, ok.

Now, you see the price of the traded good will increase by the country has started exporting the good. So, there is increased price of increased demand for the resource in the world market. Like, we know that demand for oil is very high. So, price of traded good will increase because earlier the traded good did not include the resource.

Now, a resource is discovered which is highly demanded outside. So, price of some of the traded goods will increase. The resource intensive goods will increase. And the PPF will just rotate without changing the vertical intercept. Now, when the price of the traded good increases, what will happen? Those who are selling the traded good they become richer. So, people become richer. So, when people have more income they have increased purchasing power, they now want to consume more of both traded and non-traded goods.

So, demand for both traded good and non-traded good increases. Because you see for domestic consumption purpose people are spending their income on both traded good as well as the non-traded good. So, when people become wealthier with the resource rent, they will demand more of both traded and non-traded good. So, point of production will also not stick to Q because this is the new PPF.

Suppose, we give name, suppose this was the initial PPF, PP' , and after the discovery of the resource since the horizontal intercept of the PPF gets elongated, so the new PPF becomes a PP''. So, the point of production will of course be on the new PPF because we know that the economy will always operate on the PPF, not inside the PPF, on the PPF full employment is maintained.

So, suppose now the point of production and consumption they shift to point R, ok. So, say this is the new point of production. Earlier it was before discovery of resource it was at point Q, now this is the new point of production. So, you see at this new point R, the economy is now producing more of both traded and non-traded good. Now, why traded good production is increased? That is evident because now the newly found resource is also coming under the traded sector.

So, its production will increase. But just now we mentioned that the production of the non-traded good initially remains unchanged and that is why the vertical intercept after resource discovery will not change. But you see when it is exporting the traded good, the country's earning resource wealth, the country's income increases, demand for the non-traded good also increases.

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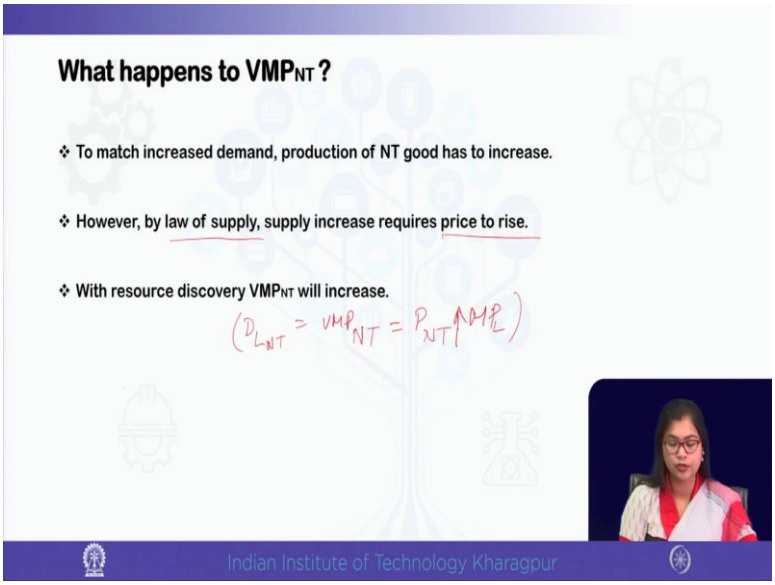

Now, if demand increases we know that to match increase demand the production of non-traded good has to increase because if demand increases price will also increase. Is not it? You remember, we already just discussed that the implication of classifying the economy into traded and non-traded sector is that, the domestic producers of the traded sector cannot respond or react to the domestic market conditions.

But the producers of the non-traded good can do so, because the price of the non-traded good is determined in the domestic market. So, what happens over here? Here when people become richer and they want to consume more of both traded and non-traded good. So, and for non-traded good, you cannot buy from abroad. So, if people want to consume more of non-traded good the supply of non-traded good has to increase.

Now, how supply will increase? See, we have already studied the law of supply which says that supply will increase if price increases. So, there is a positive relationship between price and quantity supplied, right. As price increases quantity supply will

increase. Or in the inverse form of the supply curve we can say that a quantity supply increase will need the price to be increased, right.

So, that means, if the domestic consumers want to consume more of non-traded good, the supply of the non-traded good should increase domestically because for non-traded good we cannot buy from abroad. So, that means, price of the non-traded good P_{NT} must increase, right. Now, you see what are the labour demand curves? The labour demand curves are given by the VMPL curve which is nothing but the price into marginal productivity of labour.

So, what is the VMP_{NT}? That means, labour demand in the non-traded good see. This is your labour demand in the non-traded sector D_{LNT} which is nothing but VMP_{NT}. Now, what is this VMP_{NT}? This is price of non-traded good into the marginal productivity of labour, ok. So, price of the non-traded good is increasing, ok. So, the first impact of the resource discovery happens by increasing the price of the non-traded good.

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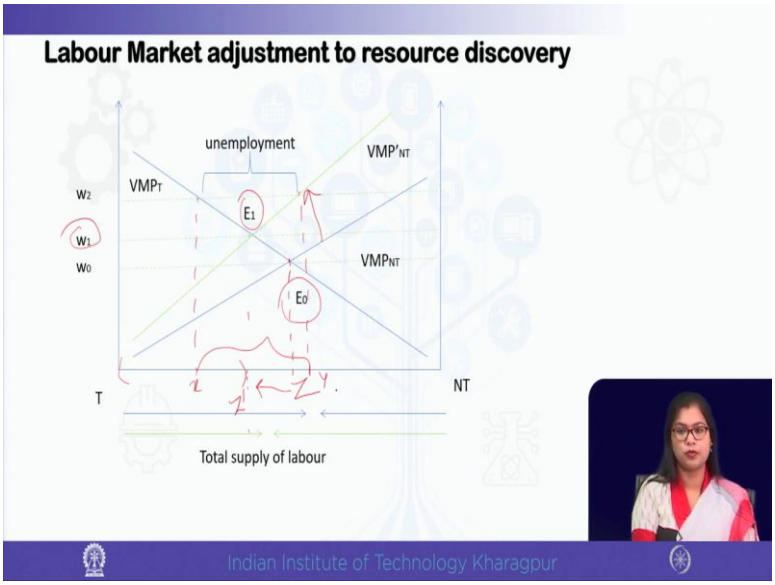

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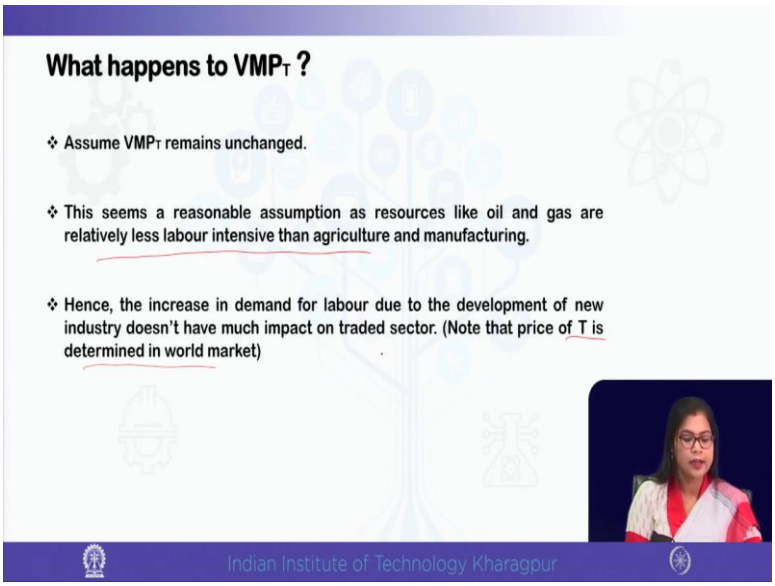

And you see the price of the traded good will remain unchanged because we have already discussed the price of the traded good is determined outside the domestic economy. And the second assumption here we are making is that you see the resource intensives the resource sector basically, it is relatively less labour intensive. Why? Because you may need some workers for extracting the resource, but you do not need that much of workers as labour is required in manufacturing or agriculture in the service sector.

Service sector we know is very much labour intensive, right. Even in the developing countries, less developed countries manufacturing, agriculture are also labour intensive. So, this resource sector is not that labour intensive as compared to other sectors. So, that means, when a resource is discovered that comes under the traded sector, since the oil and gas and this type of resources are relatively less labour intensive, so demand for labour in the traded sector remains unchanged, ok.

So, what will happen? Due to the discovery of the resource demand for labour will increase only in the non-traded sector. So, there are two reasons for this as we discussed, one is that price of the traded good is determined in the world market. Therefore, the increase in demand for labour due to the development of the new newly found resource will not have much impact on the traded sector's demand for labour. So, this is one reason.

And second is we can make a reasonable assumption that the resource sector is relatively less labour intensive. So, VMP_T remains unchanged. And we just now discussed that VMP_{NT} will increase because price in the non-traded sector will increase. So, you see with this now we represent the equilibrium in the domestic economy after the discovery of resource. So, initial equilibrium we know is given by E_0, and the blue line along the just below the horizontal axis shows the allocation of labour in the two sectors.

Now, you see we are showing the we are representing the economy in terms of the post resource discovery by the green line. So, as we just now discussed VMP_T remains unchanged, but VMP_{NT} will increase. So, the new labour demand curve will be a shifted one, ok. At a given wage rate the workers the producers of the non-traded sector will demand more workers.

So, the new equilibrium occurs at the point of intersection of VMP_T and VMP'_{NT}, that means, point E_1. And corresponding to point E_1 you can find out the changed resource reallocation in terms of this green lines. So, initial blue line shows the resource reallocation in the two sectors in terms of see, suppose we just we named it in the previous lecture as Z. So, TZ is the amount of resource reallocated to the traded sector and ZNT was the amount of resource or labour allocated to the non-traded sector.

And in the post resource discovery situation, you can see that now more labour is allocated to the non-traded sector and less labour is allocated to the traded sector. So, this is the new equilibrium. And correspondingly, the new wage rate is W_1. So, initial wage rate was W_0 at equilibrium E_0, but now with increase in demand for labour for the non-traded sector, new equilibrium occurs at point E_1 and the corresponding wage rate. Once again it is same in the two sectors and it occurs at W_1, ok.

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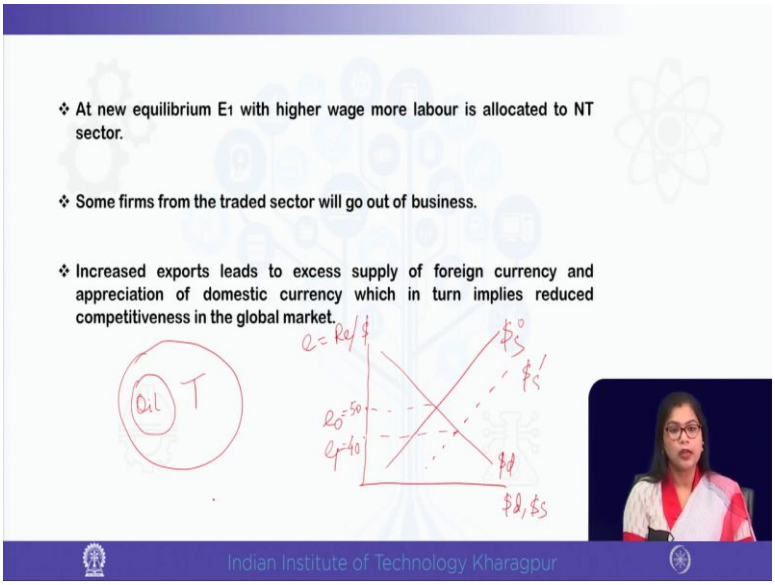

Now, you see if the traded sectors they cannot increase the price, but wage rate has increased. So, what will happen? Some of the producers in the traded sector they will go out of business. Because you see if price remains constant and then your wage rate increases, means your cost of production increases, your profit will fall. So, some of the producers in the traded sector may go out of business.

This is one reason. Because you can see that the traded sector is shrinking the amount of labour allocated in the traded sector that falls. It was earlier , now it has declined to TZ', ok. So, the traded sector shrinks. So, one is this that some firms will go out of business.

And what is the other reason? Now, other reason if you remember in the very first lecture of this module, we discussed the step by step process of what happens when resource is discovered. So, the other impact comes in terms of the exchange rate. So, what happens? You see, if you just recapitulate if we plot the demand and supply of say dollar; so, suppose we consider the rupee dollar exchange rate for our easy understanding, and we plot the demand curve for dollar and the supply curve of dollar.

We will discuss in the last module of our course is devoted to determination of exchange rate derivation of the labour, sorry the demand curve for dollar and the supply curve of dollar. And say, we are plotting the rupee dollar exchange rate e at in the on the vertical axis.

So, here what happens? Suppose, this is the initial exchange rate e_0. And now what is happening, we know that the country is selling the resource abroad. So, that mean the newly found resource because there is limited domestic demand or almost no domestic demand.

So, if the country sells the resource abroad there will be increased supply of dollar. So, with increased dollar supply, now what will happen? The dollar supply curve because you know that dollar supply is means export is one of the main source of dollar supply. So, suppose initial dollar supply was $\$_s^0$ and now the new dollar supply curve is $\$_s^{'}$, ok. So, the supply curve of dollar will now shift, ok. So, there is excess supply of dollar you see. So, increase export leads to excess supply of foreign currency.

And what will happen? That a new exchange rate will be e_1. Suppose for your easy understanding say I am giving a hypothetical example that initially e, 50 rupee per dollar, and now suppose after the discovery of resource the exchange rate has appreciated and e_1 becomes a 40 rupee per dollar.

So, that means, what? Now, earlier 1 dollar was equivalent to 50 rupees, but now 1 dollar is equivalent to 40 rupee. So, that means, rupee has become stronger. That means, I am taking this example in terms of rupee for your easy understanding, but it is the domestic currency. So, that means, the domestic currency has become stronger with respect to the foreign currency. So, this is called a exchange rate appreciation. We will discuss in depth about this in our last module.

But what is the implication? So, you may think that it is good that the currency has become stronger, but you see what is your traded sector. Say, this is your traded sector T. Now, one subset of the traded sector is the resource say this is oil, but this is oil is a subset of the traded sector, you have other traded goods also.

So, the country was also exporting some agriculture products or some manufacturing product, may be some primitive also. But some agriculture and manufacturing products were also suppose being exported. Now, what happens to this other export product apart from the resource or oil?

In other products the country will now suffer, why? Because if the country's currency, the domestic currency becomes stronger in the export market of the other goods the

country will lose competitiveness because the country's products become costlier so, the country will lose out with respect to their rivals in all other markets. So, you can see the result that the traded sector is basically shrinking in size. That means, the trade in the traded sector, the resource is gaining importance and all other apart from the resource. So, non-resource tradeable activities are getting shrinked, ok.

Because some firms are going out of business because price of the traded good cannot increase, but wage rate is increasing. And the second reason is in the export market the country is losing competitiveness in terms of export of all other non-resource goods and services. So, that is also bad for the economy because the country is getting more and more dependent on the resource or oil.

Now, you see in this graph I have shown you I have told very easily that we move from E_0 to E_1 and the new wage rate is W_1, but you see this resource reallocation it is said very easily, but it is done in reality it is very difficult, it is time taking, it is not that easy, like we are saying.

Why? Because you see we have made an assumption that there is no skill requirements or workers can know freely. But of course, you can understand that this may not be a very realistic assumption or even if there is no barrier of movement of labour within or the domestic economy across sector. So, there may be may not be any government regulation, but there may be some specific skill, ok.

So, workers may need some specific skill to move from one sector to another. So, what will happen? During this skill acquisition time, so, if the workers want to move from the traded to non-traded sector, if they have to go through some training process so, that is time taking.

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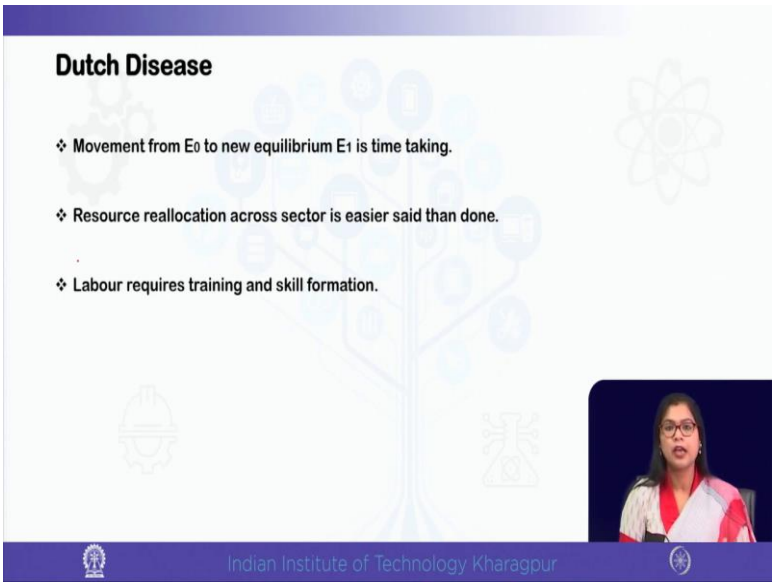

So, resource reallocation across sector is easier said than done because labour force requires training and skill formation.

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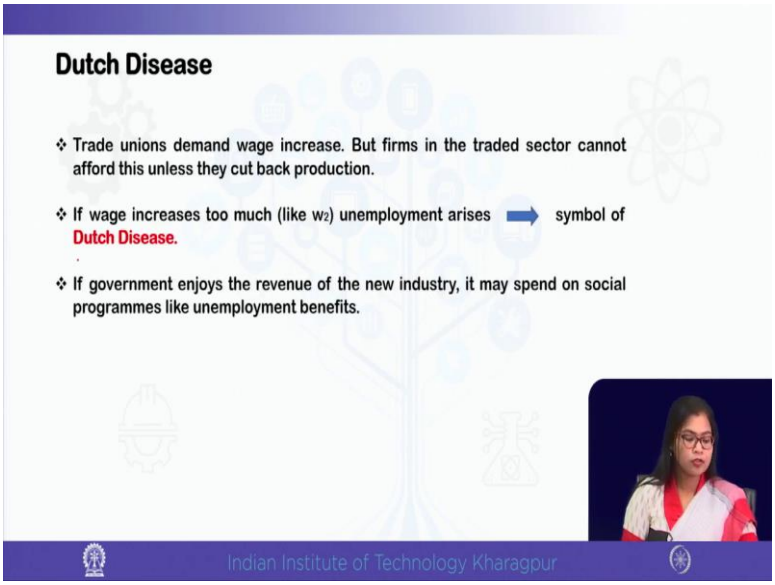

And also you see in the there may be some trade unions also which may demand a further increase in the wage rate, but we have discussed that the firms in the traded sector cannot increase the price, right. Because their price is determined in the international market. So, what they; if the workers further demand they form union and they bargain with the producers and they demand a higher wage. So, some firms have to go out of

business, the traded sector firms have to reduce their production already they are getting adversely affected in the foreign market.

For the all non-resource traded activities are getting shrinked, and also, because of the pressure from the trade union also some traded sector firms have to cut back their production. So, due to the bargaining power of the trade unions, it all depends on the bargaining power, if they want the wage to be very high like say for example, W_2. If the wage increases from W_0 to W_2, what will happen? You see at a higher wage rate now you find out we know that if the labour demand curves are downward sloping if price increases demand falls.

So, you can see at W_2 the labour demand in the two sectors, what will happen? These are the labour demands in the two sectors. So, suppose this is x and this is y. So, you can see that the total supply is given by this total the length of the box or the horizontal length of the box keeps the total endowment of labour. Out of that, this xy amount will be the resulting unemployment if the workers demand wage increase, ok because at high price of labour the demand for labour falls.

So, you can see now Tx is the demand for labour in the traded sector and yNT becomes the demand for labour in the non-traded sector. So, we have a resulting unemployment of xy amount, right. So, you see this is where the Dutch disease basically sets in. This is the symbol of Dutch disease because which there arises unemployment.

And often you see when the country is exporting the resource; the country gets oil wealth, or the resource rent if you remember we have also discussed how important the oil rents are for the OPEC countries and other oil exporting countries. So, if the government can also enjoy some part of the revenue the government can spend on social programme like unemployment benefit.

But you see these are not sustainable, right. Because for period after period you cannot pay unemployment benefits and it is a wastage of the productive factors of production also. Because the workers are demanding high wage rate that is leading to unemployment problem you see, remember in public policy we have discussed the minimum wage regulation how that creates unemployment, ok. So, similar thing is happening here.

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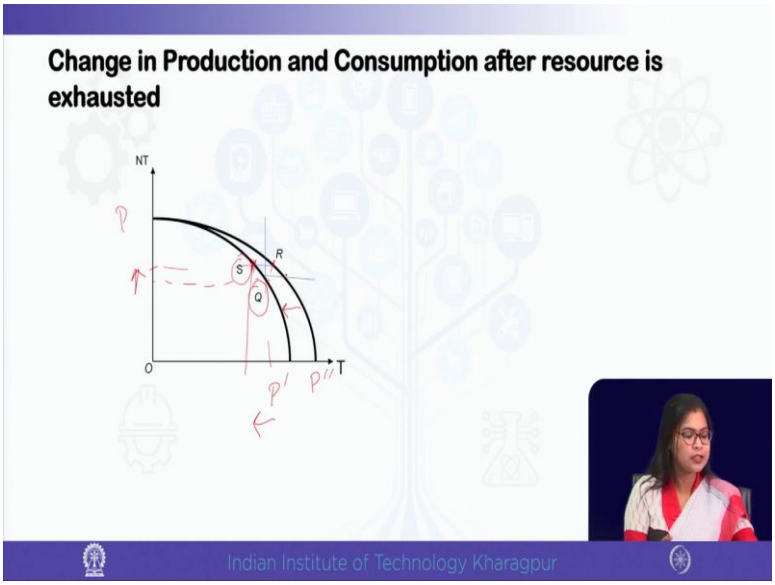

Now, let us first come back again to the production possibility frontier figure and let us see what happens to production and consumption after the resource is exhausted or the price of the resource falls in the world market. So, till now what we have discussed? We have seen that the non-resource tradeable activities are declining or shrinking there is arising unemployment, the exchange rate is getting appreciated due to which the economy is losing competitiveness in the traded good sector. So, these things we have discussed.

Now, you see what will happen if you are becoming too much dependent on your resource, the government is also paying the social benefit programmes from the resource rent or resource wealth. So, what will happen? In this way if you go on using the non-renewable or exhaustible resource, a time will come when you run out of the resource, ok.

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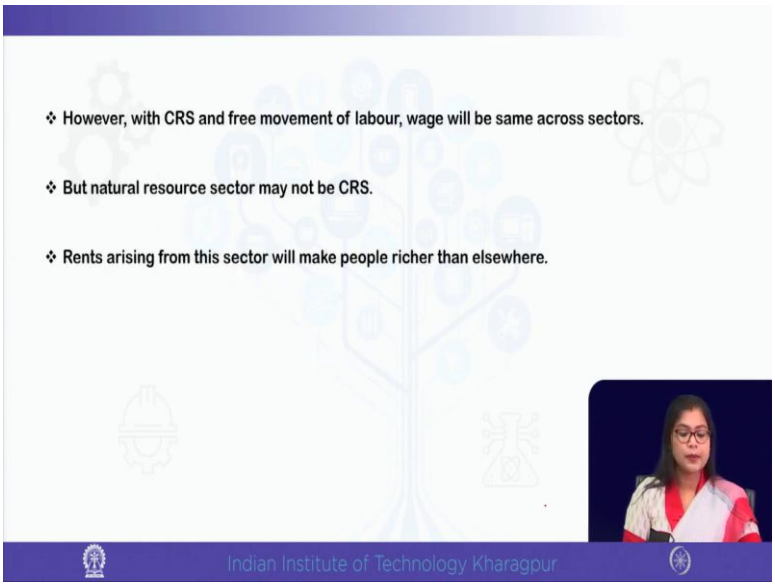

So, if you now deplete the resource or even suppose the price of the resource falls, so the country will run into a deeper problem, ok. Now, you can assume that there is constant return to scale and workers are freely movable across the sector. So, wage will be same across the sector like we have already assumed.

But we should remember that the natural resource sector like oil or other type of natural resources like gas, these are not always CRS because there is huge amount of rent. So, they may not have constant return to scale. So, they may, it may not happen like this. So, there can be unemployment problem, ok.

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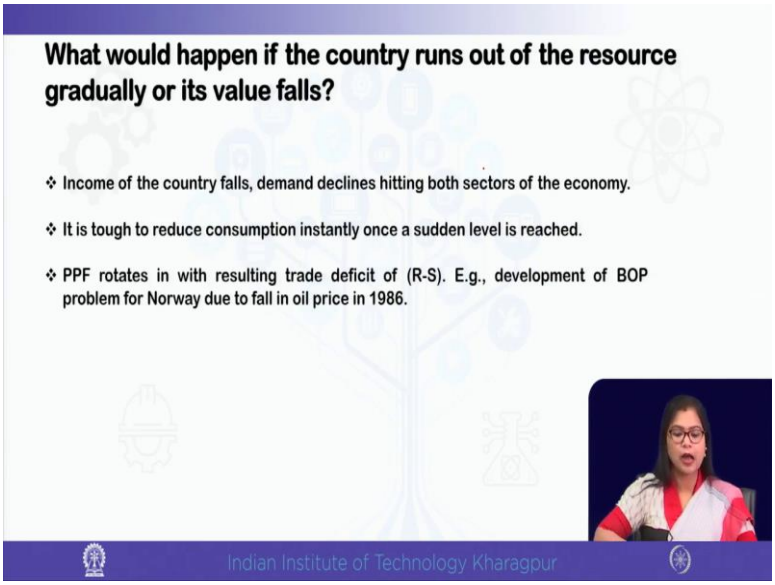

So, what will happen if now the country runs out of the resource or the value of the resource falls in the world economy or the price of the resource falls? There can be a technological improvement by which say, we have already seen that though oil price is increasing over time, but there are certain there are certain dips like the COVID-19 pandemic, the demand shock due to the pandemic or during the shale oil revolution of 2014.

So, if suddenly there is a fall in the price of the resource or the country exhaust the resource. So, what will happen? So, income of the country will fall because the country has become so much dependent on the resource. So, if income falls, we know purchasing power falls, the demand for the consumers will fall, and that will hit both the traded and non traded sectors of the economy, right.

But you see what happens, what we can see empirically also, once we get adjusted to a particular standard of living, it is very difficult to cut back that standard of living. Is not it? You get adjusted to your daily life the comforts you enjoy in daily life. So, it is really difficult to cut back the standard of living instantaneously.

But if you run out of the resource or value of the resource falls, of course, your value of production will fall. So, that means, you see what will happen then. Now, we discussed earlier that the initial point of production and consumption was point Q. After resource

discovery our PPF rotated from PP' to PP'' , and point R was the new point of production and consumption, post discovery of resource.

Now, what is happening? Suppose the country has run out of the resource or value of the resource has fallen. So, again the PPF as if is rotating inward. If the country runs out of the resource or the price of the resource falls in the world market, again the PPF rotates in from PP'' to PP', ok. But as just now we pointed out that it may be difficult to cut back consumption instantaneously, once we get habituated with a particular standard of living.

So, suppose your production now happens on the initial PPF, PP', so the production occurs at point S. But consumption remains at point R, ok. Why production is happening at point S? See, your non-traded sector has expanded. Initially, you are producing and consuming at point Q, but now you can see that the non-traded sector has expanded, the traded sector has contracted for the reasons we have already discussed.

The country is experiencing a decline in the endowment of the resource or value of the resource has fallen and the other sectors have also declined due to the fall in competitiveness arising out of the exchange rate appreciation. So, the non-traded activities are expanding, the traded activities are falling, your production now becomes the point of production occurs at the initial PPF.

So, point of production is at point S, whereas, the consumption occurs at point R. So, how do you afford? You see, how do you afford consumption beyond your production? We have only one way out that is buying from abroad that means, by importing. So, that means, what? You are importing more than what you are producing.

So, your value of import is basically your value of spending or expenditure and your value of production or is your total income. So, basically, you are spending more than what you are earning. So, that means, you run into a trade deficit, you are spending more ok. Your import bill or your total spending is greater than what you are earning.

So, you see there arises a trade deficit of this amount SR. So, you can see how we can run into a Dutch disease or how the resource cuts actually happens. So, we said very easily that we move from E_0 to E_1 and the wage rate will be W_1, but in between if we move to a higher wage rate of W_2, there arises unemployment problem or also trade

deficit as we have already seen in terms of the PPF, as the PPF rotates in and consumption is greater than the production. So, value of consumption is greater than the value of production. So, there arises a deficit.

However, so you may now ask is it now permanent won't the economy revive? Yeah, the answer is no, it is not permanent. Again, the wage rate can fall from W_2 to W_1 with time because you see how long the union can also bargain. At some point of time the workers will also start accepting a lower wage rate.

So, wage rate can gradually start falling from W_2 to W_1, and if the economy also over time it can develop the other sectors, ok. So, if the economic can prudently handle the situation and can develop the other sector. So, Dutch disease is not permanent. But you can see that how the Dutch disease happens ok.

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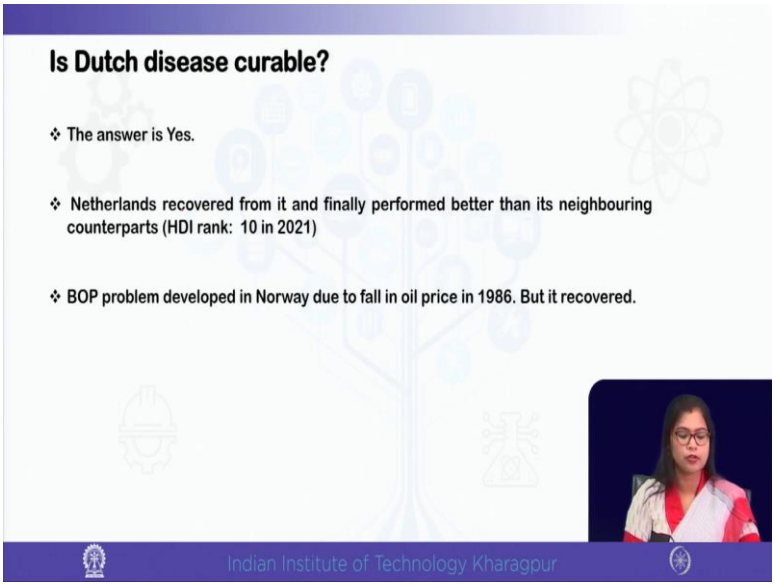

So, we can see the example of Norway also, there was a development of balance of payment problem in Norway due to the fall in oil price in the year 1986. But afterwards Norway also recovered. So, what we can conclude over here is that if we now ask if the Dutch disease is curable or not? So, the answer is yes the Dutch disease is definitely curable.

So, Netherlands also recovered from it, because you see the name Dutch disease came after the discovery of natural gas in Netherland, but we can see that Netherland actually

recovered from the Dutch disease and it performed much better than its neighbouring counterparts.

And you can see that Netherland is under the category of developed country OECD, high income country, and you can also see the Human Development Index Rank of Netherlands in 2021, it was number 10. So, Netherlands is doing quite good. Even Norway is also ranked very high in the Human Development Index. So, these economies could solve the problem of Dutch disease.

So, they could manage the relatively, but the Middle East countries are not that highly ranked in terms of their human development index, though they have started to diversify. If you remember when we analyze the oil rent, we saw that the OPEC countries were very much dependent on oil rent. But over time the oil rents have gradually declined. So, they are also diversifying their other sectors of the economy, ok.

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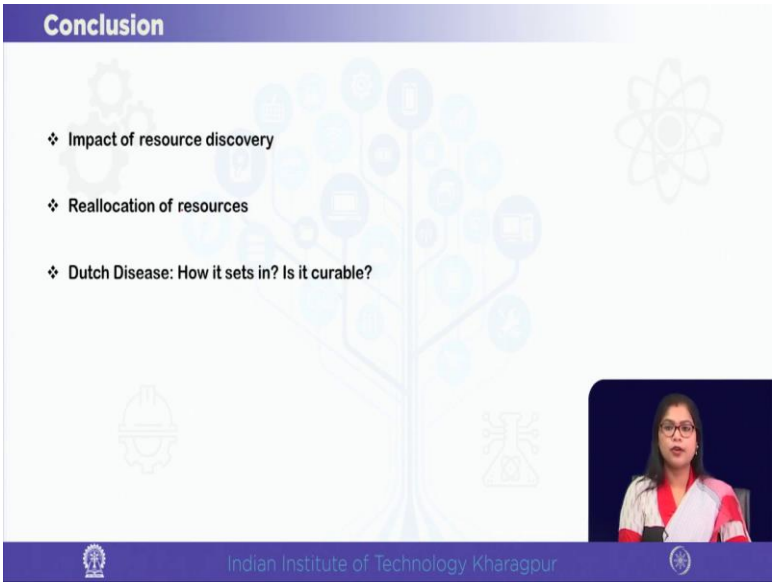

So, you see in the theoretical model, we have for in the first part of the theoretical model we set out the model, we did discuss the analytical framework, we specified the assumptions and discussed the implications of the assumption and we found out the short run production before discovery of resource.

Now, in today's lecture we started discussing what will happen once resource is discovered, how the PPF will change and how the resources will be reallocated. So, we

saw that there arises a possibility of unemployment and the non-resource tradable activity shrink because of the possibility of exchange rate appreciation.

The country will lose competitiveness. And we also see that if the country gets too much dependent on the oil wealth and at some point of time the country depletes the resource or the value of the resource falls in the world market. So, the country may run into a recession. There can arise a trade deficit because production can fall, but the consumption may be high, so the country may need to spend more to afford the standard of living. So, if the spending is greater than the earning, the country will run into a deficit.

So, we see that there are examples of Dutch disease after resource is discovered. But we finally, also found that Dutch disease can be curable because if the government can take appropriate policies, we see with empirical evidences that countries like Norway and Netherlands, they later recovered and they perform much better in terms of economic growth development and the human development index. So, we basically, discussed the mechanism of how Dutch disease occurs once resource is discovered and if the government can take appropriate policies, it can be cured also.

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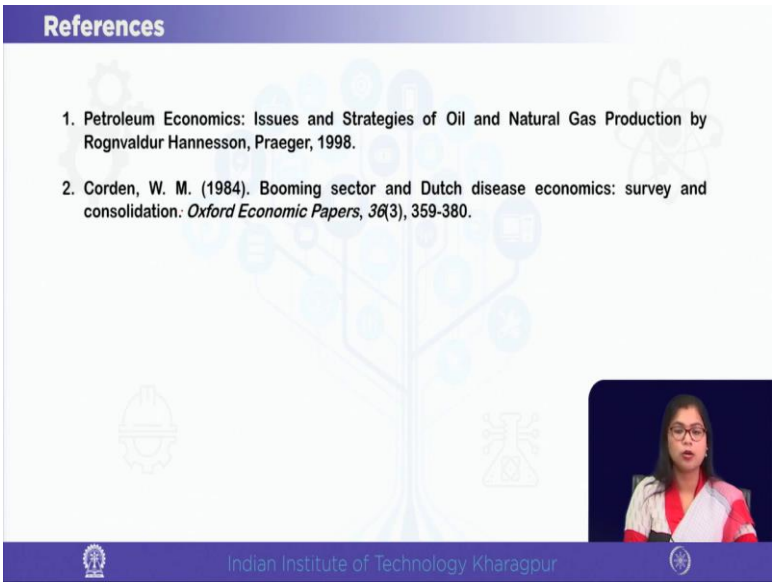

So, we mainly followed the book of Petroleum Economics by Hannesson and we also followed the very interesting paper of a Corden, 1984 for this theoretical model.

So, thank you very much.