Petroleum Economics and Management
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Module - 07
Petroleum Discoveries and Structural Changes
Lecture - 33
Theoretical model - I

Hi everyone. Welcome to the NPTEL course Petroleum Economics and Management. And I am your instructor Dr. Anwesha Aditya. So, we are in module 7 of our course, where we are discussing Petroleum Discoveries and Structural Changes. So, this is lecture number 33 of our course where we will study a Theoretical Model.

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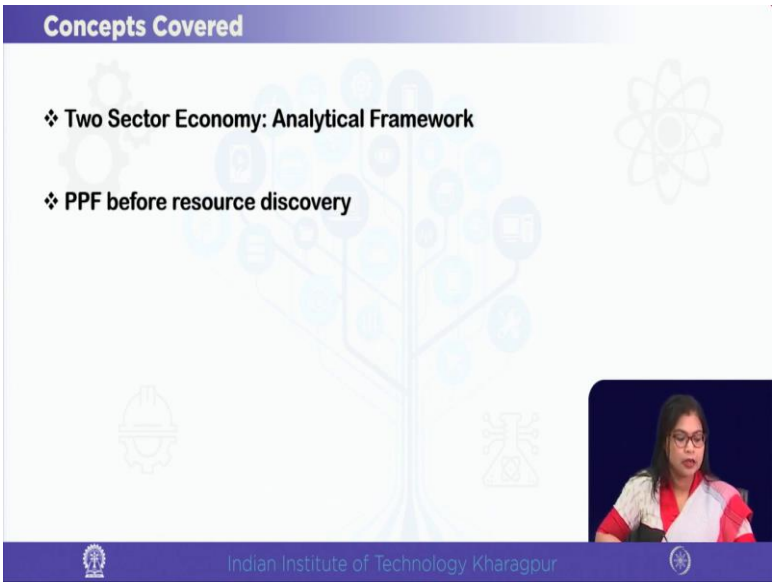

Now, the theoretical model deals with what happens to a structural change in the economy, when suddenly there is a discovery of any natural resource. So, it is not only specific to petroleum, but if there is a discovery of any kind of natural resource. So, what happens?

So, if you remember we have already discussed about the phenomenon of Dutch disease and resource curse, and we have discussed the process means the step by step process. When, often we see that if a resource is discovered that may not be good for the economy, if the economy is not able to handle the wealth prudently.

So, we have discussed the phenomena and I have mentioned that we will be studying it in a very simple theoretical framework. So, the theoretical framework will be discussed in two lectures. So, we have devoted two lectures. So, first, we will be discussing, the first part of the theoretical model where we will be outlining the model, the assumptions of the model, the structure of the model.

And then in the next lecture we will discuss what happens when a resource is discovered. So, the theoretical model is divided into two lectures. So, today, we will be focusing on the first part of the theoretical model, ok.

And then the last lecture in module 7 will deal with the country experiences, because we have to see how for the theoretical model that we have we are studying in this module in these two lectures, lecture number 33 and 34, how they hold in reality? So, whether the empirical experiences of the countries they go by the theoretical findings.

So, or the construction of the theoretical model, right. So, see what is the difference between a theory, theory and law? Law is what we observe empirically, and theory is when we start with some assumptions and we get some result based on some assumption. So, here in our theoretical model, we will also start with some very simple assumptions.

So, to keep things very simple, we follow a two sector economy. And then, we will be discussing about the structure of the economy before the discovery of resource.

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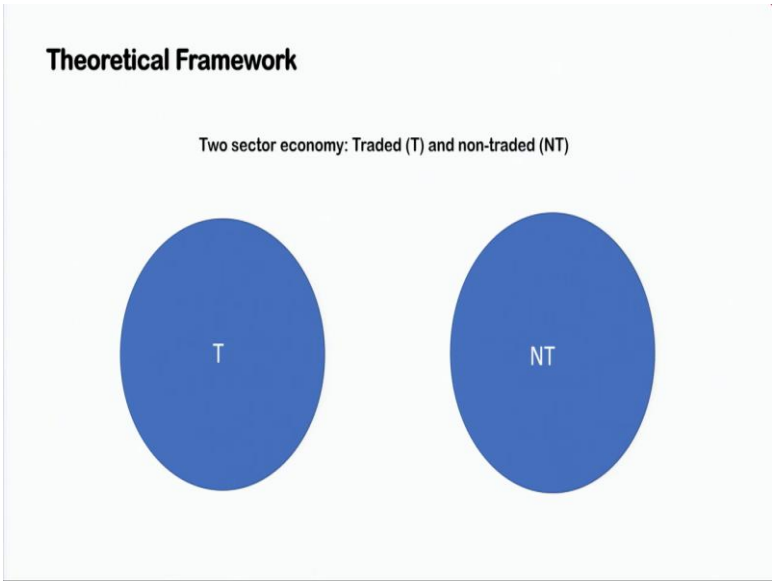

So, let us first consider economy where there are two sectors one traded and another non-traded sector. Now, you see if you remember I discussed in earlier classes also that often these two sector economy make sense, because what happens?

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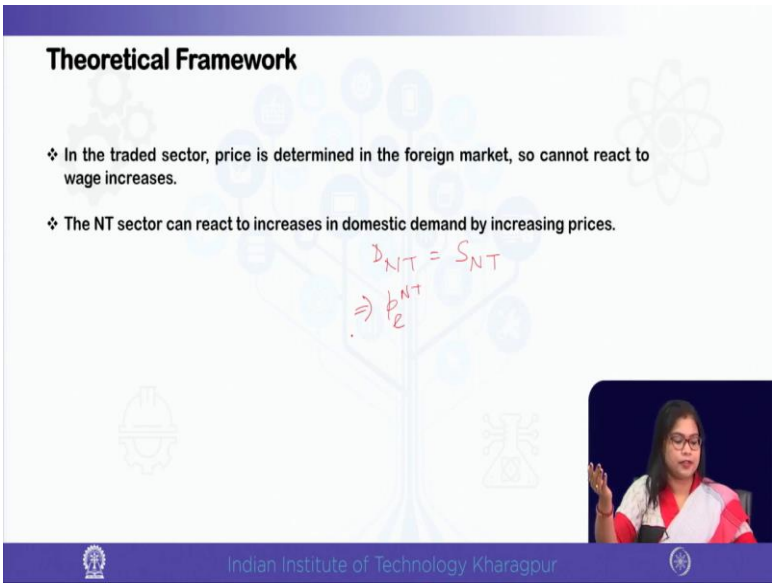

In a two sector economy, you can consider one of the sector as very important and the other sector you can consider as composite of all other remaining goods or sectors. Let us say if you remember in theory of production also, I have given you the example. You can consider one of the good as very important good like your laptop or mobile phone, and you can club all other goods.

The advantage is that we can often represent graphically or visual representation is easy with a two sector model or two good model. So, with this idea we have considered a two sector economy.

So, one is a traded sector; that means, it includes all the exported and imported item and another is a non-traded sector; that means, the items which are not traded, ok. Means, the in the non-traded sector what happens? Whatever be the domestic production it should be domestically consumed.

So, you cannot produce beyond what is domestically demanded, right because your domestic market needs to clear. So, the market clearing condition is demand should be equal to supply.

Now, you see in the traded sector that is the main point of distinction. In the traded sector, you can produce beyond your domestic demand also because you can export the good. If the good is demanded abroad, you can sell the excess supply in the foreign market.

So, suppose in your domestic economy you do not have enough demand. Like we have already taken the example like when oil was discovered in Saudi Arabia, it was a poor province in the Ottoman region. So, the domestic demand for oil was less. So, Saudi Arabia exported the oil.

Now, this is possible only in the traded sector. So, if you have the possibility of engaging into transaction with the rest of the world. You may not have sufficient domestic demand, but the good or service is demanded outside. So, you can sell it. The same happens even you can also consume beyond your domestic production. Suppose, you need something in greater quantity than what is domestically available. Let say take the example of petroleum products in India.

So, our domestic endowment is very less, right. If you remember we have also seen with data the proof reserve of India and other countries many other countries. So, we know already, we have discussed it many times that India is a major importer of energy under large part of India's energy import is or energy demand is satisfied by petroleum products, right.

So, our domestic supply is less, but our demand is more. So, we import. So, you see when the export import facility is there. So, you can consider those sectors at traded sector. So, we are basically clubbing all the traded goods under this T sector which we are denoting as T that stands for traded, ok.

So, we are clubbing. So, there can be n number of sectors under this particular traded sector. And the other sector is the non-traded sector where the domestic demand should be equal to domestic supply because you cannot export and import.

Nowadays you see, nowadays it is difficult to find out a really non-traded good because mostly we can engage into transaction with the rest of the world even for services also, right. With the improvement in ICT infrastructure even the services are also now

tradable like say banking services, financial services, even telemedicine at online education.

So, ICT has enabled many earlier non-traded services to be tradable. But till there are some type of non-traded services also which can till now is not tradable. So, one such non-traded service is salon service or hair cutting service. So, you can also consider that some of the sectors are not engaging into any kind of transaction with the rest of the world. So, we are clubbing those sectors under this non-traded services.

So, when this theoretical model was constructed in 70s, 80s, at that point of time many of the services were non-traded earlier. So, we consider one domestic sector which is not engaging into transaction. So, there can be again some, it is not only one sector there can be few sectors which we are clubbing as a whole under the non-traded sector, ok. So, you have a traded sector where there is export and import and there is a non-traded sector.

Now, what is the implication? Implication of classifying the sectors in terms of traded and non-traded is as I just mentioned for the non-traded good your domestic demand say DD is equal to the domestic supply for the non-traded good. So, domestic demand of the non-traded sector should be equal to the domestic supply. That means the price is determined and that is how you get the equilibrium prices.

Suppose, this is the equilibrium price P_E of non-traded good, ok. So, you can get the equilibrium price by equating the demand and supply. So, your price is determined domestically. Now; that means, now what will happen, if suppose there is a demand side shock or there is a supply side shock. So, what will happen? Your price will adjust.

Suppose, the wage rate increases, there is increase in demand for labour. So, we know that the cost of production will increase. So, what will happen? Price will also increase. If the supply curve, then shifts, if your cost of production increases, we know that the supply will fall; that means, the supply curve shifts in. Therefore, what will happen? Then, price of the good can change, ok.

So, in the non-traded sector the producers or the suppliers or the sellers, they can respond by changing their prices if there is a disturbance in the demand side or supply side. Even if there is a fall in domestic demand of the non-traded good then price will fall. So, the price in the non-traded sector can respond to the domestic market conditions.

But that may not be the case in the traded sector. Why? Because for the traded sector the domestic market clearing conditions may not hold. Because if domestic market is clear, if your domestic demand is exactly equal to your domestic supply, then you are not exporting or importing, right.

Because you see what is export, like India exports lot of gems and jewellery. What is this export? This export is nothing, but excess supply. So, our domestic supply is greater than domestic demand. So, export of a good is nothing, but the excess supply in the domestic market by that country, ok.

Now, if the domestic market clears demand is equal to supply, so there will be no export. So, that means, in the trade and sector the domestic markets do not clear. So, your exporting gems and jewellery if there is a demand abroad. So, basically, the price is determined in the world market.

Same thing for petroleum in the petroleum market, we are importer. Our domestic demand is much greater than domestic supply. So, this excess demand or this unfulfilled demand we have to buy from abroad. So, this is our import amount and we know that India is not the decider of price of oil. So, our domestic market price also varies with respect to the global oil price, ok.

We have already talked about the price index. The crude oil index like the Brent crude oil and the WTI price index, we have discussed about that. India follows the Brent crude price. So, you see the in the trade and sector the price is determined in the international market. So, what does that mean for the domestic producers? For the domestic producers, now if there is a change in the demand side or supply side within the domestic economy, they cannot change the price, right.

Suppose, the domestic demand increases or in the supply side say wage rate increases, the domestic producers; see you are importing the excess demand, but there is some minimum domestic supply. Let us say for petroleum also.

So, if suppose there is an increase in wage rate, so the domestic producers cannot change the price because the price of the final product is determined outside the domestic country, ok. So, this is why we can say that in the trade and sector price is determined in the foreign market, the domestic producers cannot react to increase in wage rate by

changing the price. as if they take the prices given, the price is determined in the wall market.

So, this is the main implication as far as the pricing strategy of the two sectors are concerned. So, non-traded goods sector price is determined in the home market, for the traded goods prices determined in the international market, ok.

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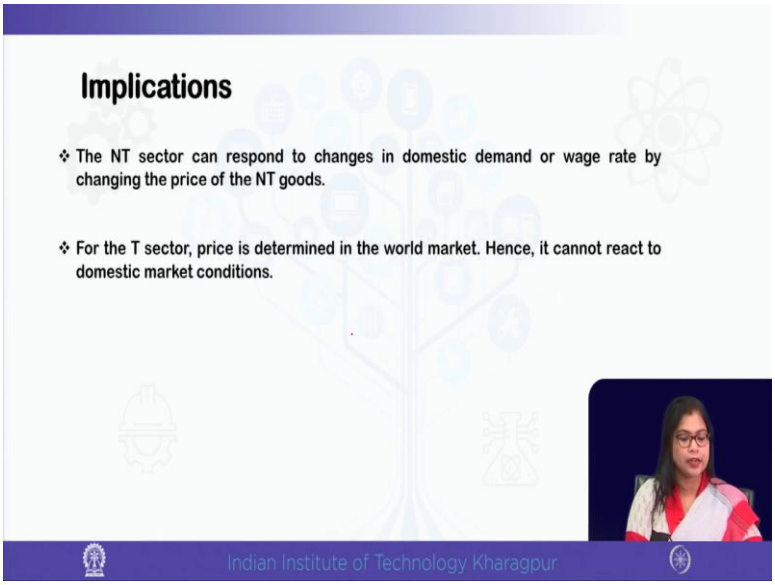

So, we have already discussed the implication. So, in the non-traded sector the producers and the sellers can respond to changes in the demand supply condition. However, in the traded sector the producers and sellers cannot respond to the changes in the demand side or the supply side conditions.

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Now, we will start with some assumptions. So, we are assuming perfect competition in the goods market and the factor market. However, later we will also bring the role of trade union, often we have the workers can form union. So, we can investigate what happens if the workers have some market power, monopoly power, they join together they form union and if they have bargaining power how they can influence the outcome.

So, later we will introduce some kind of imperfect competition in the labour market. But initially we will start with perfect competition. And also, we consider labour is the variable factor of production and capital is the fixed factor.

Now, you remember in theory of production we have already discussed, that in the short run some of the factors of production cannot be varied. So, that is called the fixed factor. So, capital is the fixed factor of production, but labour can be varied in the short run and we are considering labour as the only variable factor. However, in long run all the factors of production can be varied, ok.

Now, also we are assuming following the neoclassical theory. We are not distinguishing between skilled and unskilled worker. So, we are considering labour as homogeneous and also, we are considering capital as homogeneous, ok.

So, we are not making any distinction within labour group or within capital group, ok. So, labour just we are not considering, that some labours are semi-skilled or unskilled

and some are highly skilled. For the time being, we are not bringing any type of skill difference within the work force. So, this is a very standard assumption used in neoclassical models.

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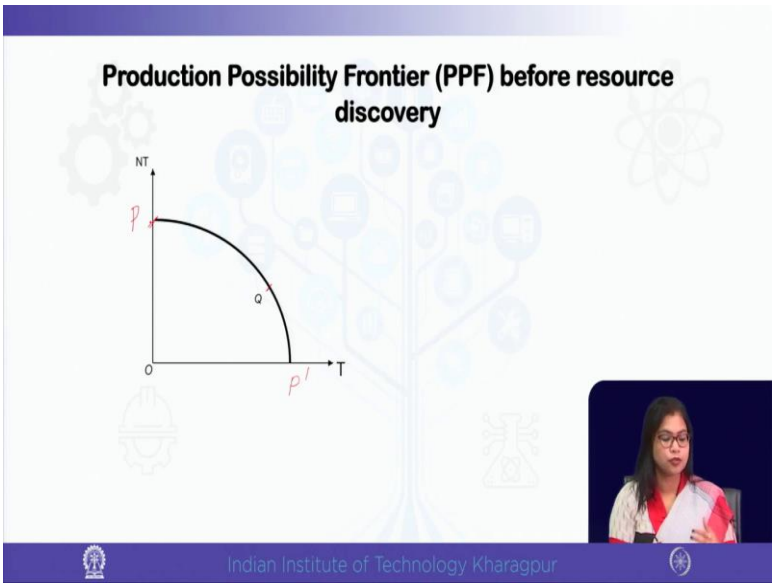

Now, with these assumptions and the two sector structure, let us now see the point of production and consumption before the discovery of resource. So, initially, at the starting point suppose we represent the economy in terms of the production possibility frontier. Now, you remember we have already discussed about production possibility frontier, its negative slope, the implication, and also we have discussed in depth about the concavity of the production possibility frontier, right.

So, I am not going to elaborate on that. So, diminishing marginal productivity along with non increasing return to scale will make the PPF concave. So, we have a standard concave PPF, ok. So, I am not elaborating. So, you can refer to the previous lectures, if you have any doubts regarding the slope and the shape of the PPF and the interpretation of the slope of the PPF.

So, suppose, initially we are at point Q, let us say here in the in this figure. So, suppose this is your point of both production and consumption, ok, initially. And if you remember we have also discussed that any economy which is maximizing its welfare will always operate on the PPF because inside PPF we have unemployment because we are not utilizing the resources efficiently or fully. So, that is why on the PPF which is the

boundary or the upper limit of your production possibility set, so the country is operating on the PPF.

And of course, if the country is producing on the PPF and without engaging in international trade, the consumption is also limited by PPF So, in previous lectures, when we discussed about PPF we said that the PPF puts the upper limit on countries production possibility. So, you cannot produce beyond the PPF given particular amount of resource and given state of technology.

If there is a technological improvement or there is a discovery of resource, then you can go beyond your PPF. But with given endowment of resource and a particular level of technology you cannot go beyond your PPF. And in the consumption side also, see if you do not allow the country to engage in international trade. So, you cannot buy or you cannot consume more than your domestic production; that means, your consumption is also limited by PPF.

So, not only the production, until and unless the country can engage into international trade country's consumption is also limited by the PPF. So, suppose initially the country is producing and consuming at the same point, so domestic market is clearing, ok.

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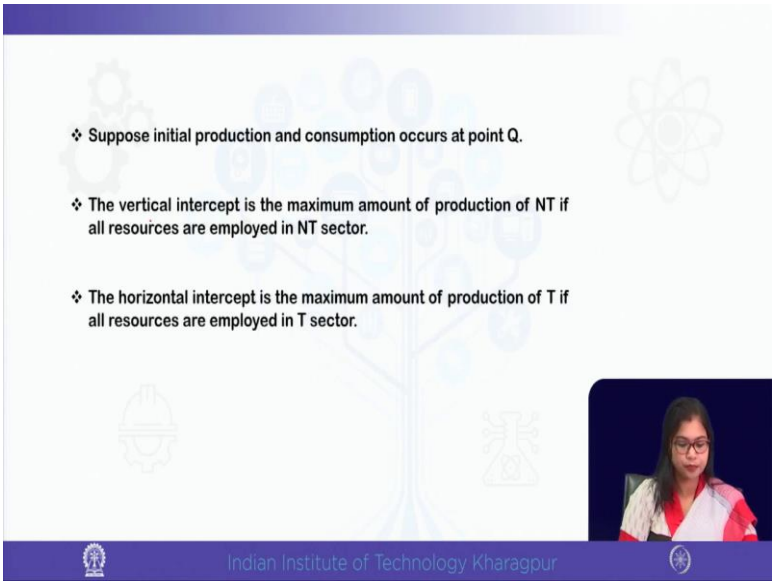

So, initial production and consumption occurs at point Q. Now, you see before proceeding further, one thing we need to understand is the interpretation of the two

intercepts of the PPF. Suppose, we give this intercept, suppose the vertical intercept is the length OP and the horizontal intercept is the length OP', ok. So, how do we interpret these two intercepts? So, what is this point P signify?

Now, you see what does it mean. P means what? P means of course, you can understand when at point P the production of good T is 0, right. So, that means, what? This vertical length OP signifies the maximum amount of production of the non-traded good if the country is not producing at all of any traded good.

That means all the resources are fully employed in the production of non-traded good. So, that means, it is the maximum possible amount of production of the non-traded good with full employment and given technology because all your factors of production are fully employed at point P, ok. So, basically, we can say that this point P is the point of complete specialization in non-traded good by the country, right.

Because the country is devoting all its resources in producing only one good. The country is not producing any other good. And of course, we know that on the PPF or along the PPF full employment is maintained.

So, in same fashion we can also interpret point P dash as the point of complete specialization in the traded good. So, if that means, if the country is operating at point P dash this keeps the maximum amount of production of good T if the country is not producing any amount of the other good NT and all the resources are fully devoted in the production of traded good.

So, these two intercepts are the maximum possible limits of production of these two goods, ok.

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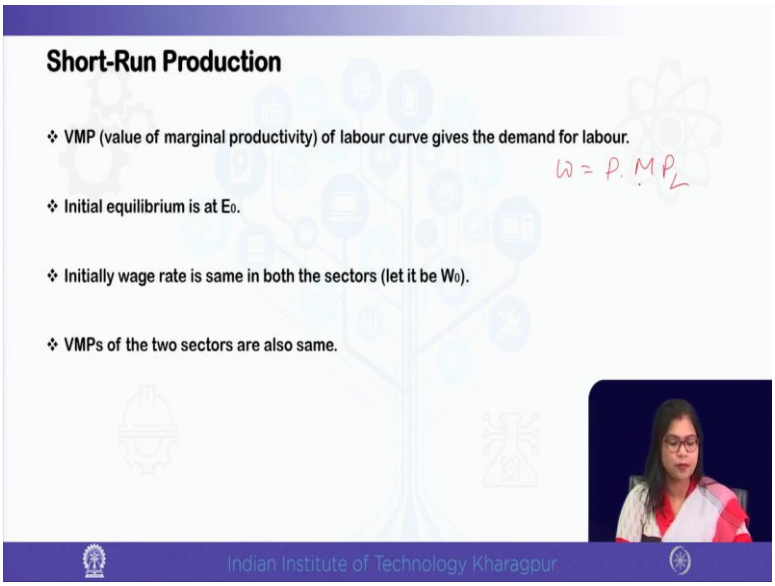

Now, with this interpretation, we will now show the domestic labour allocation or domestic equilibrium condition, ok.

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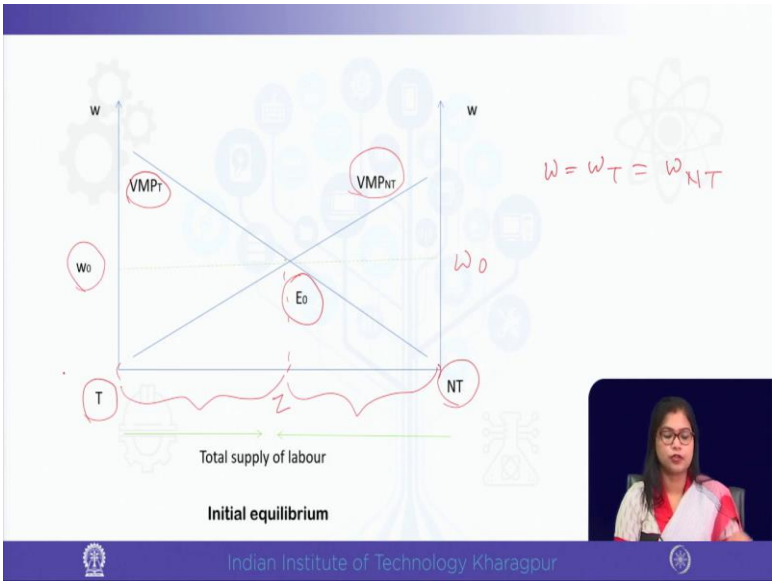

So, you see we are plotting the two goods in two point. See, we have drawn ah figure to represent the allocation of labour in the between the two sectors. So, we are plotting the traded good sector in the left hand side and the non-traded good sector is plotted in the right hand side, ok.

So, you can plot two separate figures also for traded and non-traded, but this is kind of a box diagram. So, this is a convenient way to show resource reallocation across sector. We often use to we use this type of figures to show the resource reallocation within the domestic economy, across sectors.

So, you see we are plotting the two in same figure to show that how resources are reallocated, means how much labour is devoted to traded sector and how much labour is devoted to the non-traded sector, ok. Now, what we are doing in this figure? We are plotting the short-run productions by plotting the labour demand curve. So, if you remember we have already derived the labour demand curve in one of our classes.

So, what is the labour demand? We have discussed that labour demand is given by the marginal revenue productivity of labour, right, the which is defined as the additional revenue that a firm can get by hiring one more unit of labour. Because when a firm hires one unit of labour, so output will change by marginal productivity of labour MP_L.

Now, what the firm will do? The firm will sell this additional output. And what the firm will earn? The firm will earn marginal revenue by selling that additional output. So, you can interpret the contribution of the labour as marginal revenue productivity of labour. Now, you remember under perfect competition P is equal to MR. So, what is the demand for labour? In the under perfect, competition demand for labour is given by P * MPL or VMP_L equals to W.

So, in perfect competition the factors of production are paid according to their value of marginal productivity. So, we have already discussed about the marginal productivity theory of factor prices. So, in the short run, if labour is the variable factor, the VMP_L curve or the value of marginal productivity curve gives the demand curve for labour.

And we have also discussed why it is negatively sloped. You remember, it is negatively sloped by the law of diminishing marginal productivity. So, just for your brief recapitulation. So, this was our labour demand.

And since we have law of diminishing marginal productivity operating, if you employ more and more labour with constant amount of capital, we have studied that output will first increase at an increasing rate and then at a decreasing rate. Therefore, due to the law of diminishing marginal productivity the labour demand curves are downward sloping.

See, we have plotted the labour demand curve of the traded sector which is given by VMP_T and similarly VMP_{NT} is the labour demand curve for the non-traded sector. So, for the non-traded sector, see we are plotting with respect to this right hand side, where we are showing the non-traded sector and this is the traded sector. So, we are plotting as usual always quantity comes on the horizontal axis. So, this is the amount of labour.

So, basically the length of this horizontal segment here you can see, this is the total supply of labour. And what is the vertical axis? We know that we plot price on the vertical axis. So, as quantity here we are plotting the amount of labour, total labour supply and demand. So, of course, in the vertical axis it will appear as the price of labour which you can interpret as the wage rate, ok. So, W is the wage rate.

Now, you see we do not have a separate wage rate W_T and W_{NT}. Why? Because of some of our assumptions because even if the wage rates are supposed to start with let us say W_T and W_{NT}s are different. Now, you remember we have already just now discussed that we are considering labour to be homogeneous; that means, the same labour can be employed in both traded and non-traded sector.

So, suppose if it so happens that the wage rate in the traded sector is greater than the wage rate in the non-traded sector and if the there is no skill difference. So, what will happen? If the wage rate in one sector is greater. So, the workers will migrate from the other sector to the high paying sector, if there is no skill difference and also there is no restriction on migration of labour across sector.

So, if there is no restriction, so labour can freely move across sectors there is perfect competition. So, workers will move from one sector to another. So, what will happen then? If suppose the traded sector was paying a higher wage rate. So, more workers will come from the non-traded sector and they will join the traded sector. So that means, there will arise excess supply of labour in the traded sector. So, wage rate in the traded sector will fall.

And since workers are coming out from the non-traded sector. So, there the wage rate will also start increasing because there will arise relative scarcity of workers, ok. So, again you see wage rates will be equal. So, that is why we are not having any different wage rate W_T and W_{NT}. So, we are just writing W which is same for both the sectors, ok.

So, it is happening mainly because there is no restriction on movement of labour within the domestic economy across sectors and there is no such skill difference, ok. Same labour can be absorbed, if they are displaced from one sector they can be absorbed in the other sector.

So, with these you see now, what is the initial equilibrium? Initial equilibrium occurs at point E_0, where the labour demand curve of the two sectors are intersecting each other. So, you can see how much labour force is employed in the two sector, ok. So, suppose this is a point Z. So, TZ amount of labour is employed in the traded sector and Z NT amount of labour is employed in the non-traded sector.

And also, you see the wage rate the in equilibrium wage rate you can get at corresponding to the initial equilibrium E_0 is W_0 which is again same. So, equilibrium wage rate is W_0. For the reason I told, if the wage rate is greater in one sector workers will migrate, ok. So, at the equilibrium the labour demands are also same. So, we see the allocation of the factors of production or labour which is the variable factor in the short run in the two sector economy before the discovery of the resource, ok.

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So, you see in this lecture what we have done, we have discussed the analytical framework of a theoretical model. So, we started with the description of the model, we discussed the assumptions of the model and then we specified the implications of the

assumptions and finally, we represented the model in terms of the PPF as well as the labour demand.

So, how much of the factors of production that is labour is allocated between the two sectors. So, this is what we have done in today's lecture. So, so, what we will do in the next class? We will now specify how the economy will change, how the resources will be reallocated, what will happen to production and consumption when there will be resource certain discovery of any natural resource. It may not be specific to petroleum or any other natural resource.

So, what will happen to production and consumption of the both traded and non-traded goods, what will happen to resource reallocation, what will happen to the wage rates and how that may lead to the problem of Dutch disease and whether Dutch disease will be curable or not. So, this is what we are going to discuss in the next lecture.

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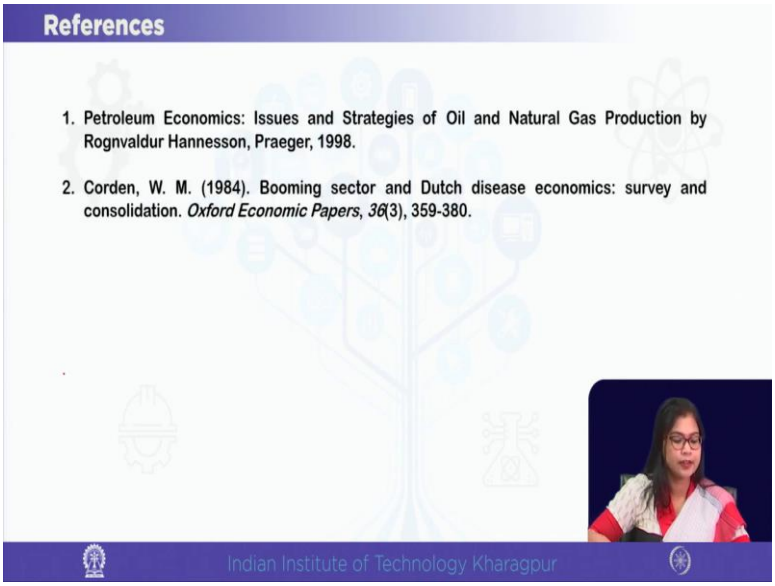

So, we have mainly followed the Petroleum Economics book by Hannesson and another interesting paper by Corden, 1984.

So, thank you very much. Look forward to meet you in the next lecture.