Petroleum Economics and Management
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Module - 02
Basics of Microeconomics
Lecture - 09
Equilibrium

Hi everyone, I am Dr. Anwesha Aditya Assistant Professor in the Department of Humanities and Social Sciences of IIT, Kharagpur and I am your instructor for the course of Petroleum Economics and Management. In today's lecture nine module two, we are going to study about how to get the Equilibrium?

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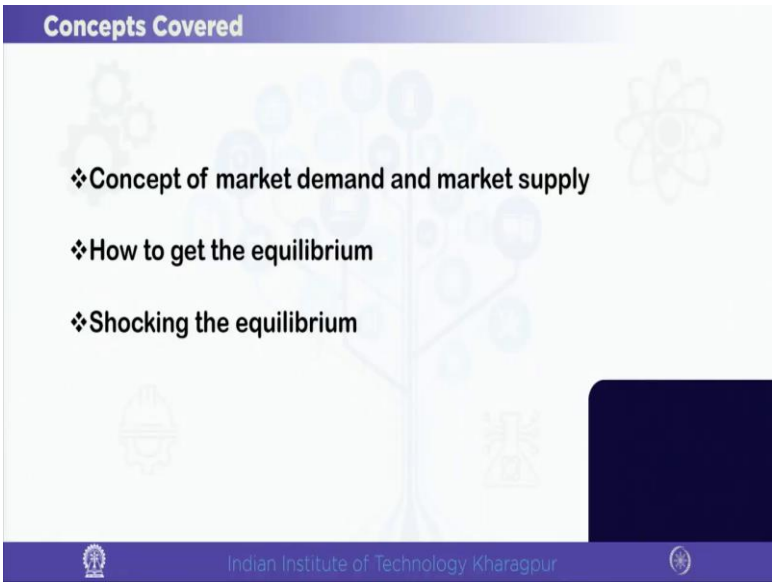

So, if you remember the way we have structured the syllabus, we are going to spend quite lot of time on the movement of oil price and how the recent global events like the COVID-19 pandemic or the Russia Ukraine war have impacted oil price. So, for this we need to know how price is determined in a market.

Because we have to study the global oil market. So, we need to know some basic of functioning of market. So, with this idea in mind we have included some basic concept of economics mainly of microeconomics.

The concepts of microeconomics are taught only to the extent which is required to study our course petroleum economics and management. Because to have more number of audience more, industry professionals and students for various discipline, they get benefited from our course therefore, there is no prerequisite. But some basic understanding of economics is required.

So, with this we are studying in module two, the basic of microeconomics. So, if you remember we have already defined a market so there are two parties in a market the consumer side and the seller side. Now, we have studied these two sides separately. We have already studied the demand side, we have studied the supply side. So, now, time has come where we should put the two together to find out how the equilibrium quantity transacted is decided in a market and what will be the equilibrium price.

Suppose we are referring to a petroleum price. So, how does it get determined? How this petroleum price is determined in the world market we need to know that. So, this is the purpose of studying the lecture content of today's class. So, first we will derive what we know as the total demand and total supply. Because if you remember we have studied the concept of demand and supply for individual economic agent a representative consumer for demand and a representative producer for the supply side.

Now, time has come that we get the demand and supply for the entire market to get the market equilibrium. Because when we are referring to equilibrium so that outcome refers to the market as a whole. Therefore, in today's class we will start by deriving the market demand then we will derive the market supply. Next, we will go to the equilibrium transaction. So, we put market demand and market supply together to get the equilibrium.

Now, after the equilibrium is arrived at so how the shocks in the demand side and supply side? How they are going to disrupt the market like the COVID-19 pandemic let say. So, we have already discussed that during the pandemic and the initial phase of lockdown on April 20, 2020. So, oil price the future contract WTI price became negative.

So, how these type of shocks affect the world oil price and the quantity transacted. So, we need to know if there is a shock in the demand side or in the supply side how the equilibrium will be disrupted? So, these are the contents to be covered in today's class.

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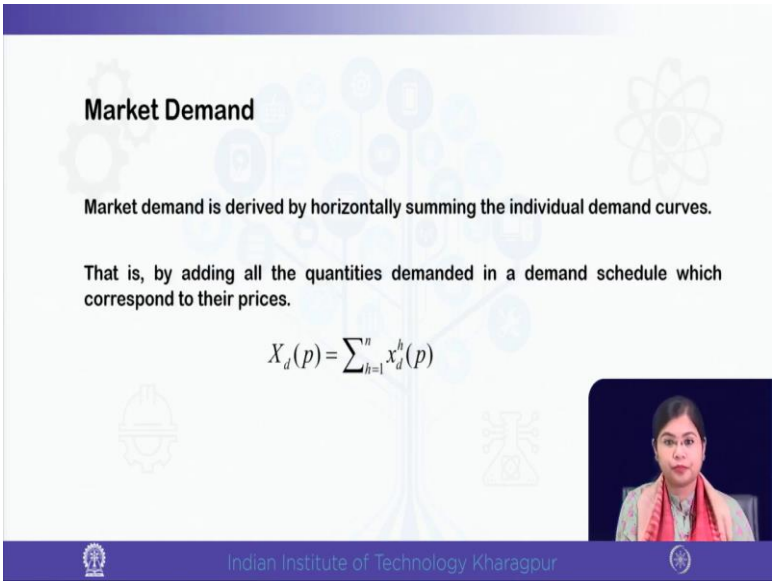

So, first topic in today's class is to get the market demand or the aggregate demand from the individual demand. Because, we have derived the demand function and we have drawn the demand curve to be more specific the inverse demand curve for individual economic agent a representative consumer.

Now, time has come that we aggregate it over all the consumers in the market. So, the idea is very simple. So, we already have defined the demand curve is the relationship between quantity demanded for different prices right. So, what is the market demand? So, for market demand we have to add the quantity demanded by each of the consumer to get the total demand.

So, suppose for a particular price at a particular point of time how many consumers are buying the good? So, if we have to add the quantity demanded of all the consumers. So, graphically we can do it by horizontally summing the individual demand curve. So, we can define the market demand as capital X_d.

So, just to clarify capital letter stands for market. We can also use the notation Q as I already mentioned that we can use X or Q to represent quantity demanded. So, X or Q will stand for market and x or q will stand for the individual economic agent.

So, capital X_d is the market demand for good X. So, that will be equal to summation of x_d^h (p) where h runs from 1 to n. So, if there are n number of consumers. So, at a given

point of time, if there are n number of consumers the market demand of good X, X_d as a function of p is equal to summation x_d^h (p) where h runs from 1 to n. So, we have to add for all the individual consumers to get the market demand.

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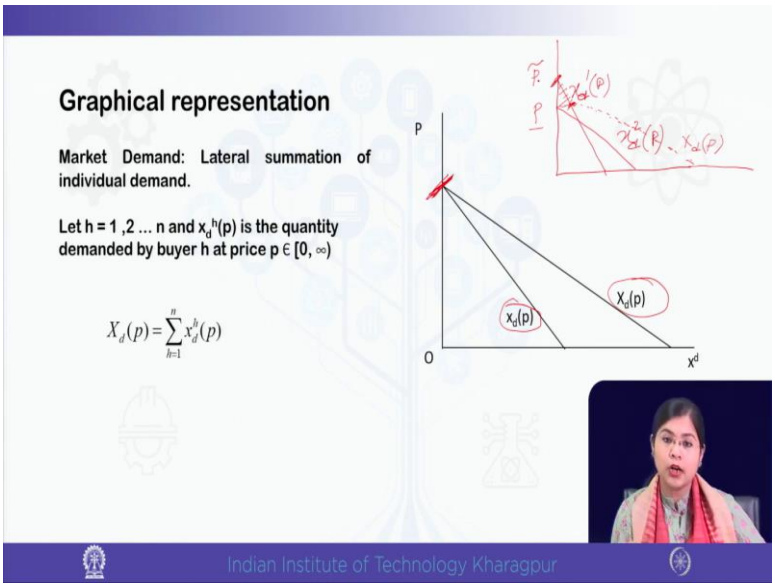

So, this is how we can derive it graphically. So, at each price we have to add the quantity demanded. Suppose there are 100 consumer. So, what we do? So, it will be X_d will be 100x. Now, the consumers can be homogeneous; that means, they can be having the similar type of preferences or they may not be having the similar type of preferences; however, the idea is same at each price we have to add the total quantity demanded.

So, if there are n number of consumers so let h runs from 1 to n and x_d^h (p); that means, the quantity demanded of h^{th} consumer is a function of price p for any positive price. So, the total quantity demanded will be summation x_d^h (p) where h runs from 1 to n. So, that is how we have graphically derived the market demand you can see. So, this is our individual demand x_d and this is the market demand ok.

So, here we have assumed that the consumers are alike so that everyone has the same maximum willingness to pay price. Therefore, the market demand curve also starts from the same vertical intercept. But we may be having different cases where two consumers can be having different maximum willingness to pay prices and we can have this type of demand function for consumer 1 x_d^1(p) and consumer 2 x_d^2(p), but the idea will be same.

So, we have to add the total quantity demanded. Here we can see that the maximum willingness to pay price for consumer 1 is greater. Suppose this is p tilde and the maximum willingness to pay price for consumer 2 is less. Suppose this is p under bar. So, what we do? We see that if price exceeds p under bar. So, consumer 2 is not able to buy the good. So, what will happen? Therefore, for any price in the range p tilde to p under bar there will be only one consumer in the market.

Therefore, the market demand curve will be just corresponding to the individual demand curve of consumer 1 and after that what will happen? After that both the consumers will buy the good. Therefore, for any price less than p under bar there are 2 consumers in the market. So, what we do? We add the total quantity demanded to get the market demand. So, the market demand curve will be like this capital X_d. So, it is as simple as that.

So, we add the quantity demanded for each consumer to get the market demand curve whether the consumers are alike or not that does not matter. So, if the consumers are alike. So, the market demand will have the same vertical intercept. If the consumers are not alike then the market demand curve may have a kink because when we say that the consumers are not alike we mean that the maximum willingness to pay price may not be the same.

However, in reality we do not have a market with two consumers only ok. In the demand side, in the consumer side we assume perfect competition. So, there are many consumers. So, if all of them are say different or the consumers have different maximum willingness to pay prices. So, you will be having kink in the demand curve, but if there are lot of preferences.

So, there are lot of maximum willingness to pay prices. So, ultimately you get a smooth demand curve because the kinks will be smooth out ok. So, this is how we get the market demand. So, this is our first part in today's lecture. Now, what we need to do? To get the equilibrium we need to derive the market supply.

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So, here also the notion is same the idea is same. Total supply is the total quantity produced by all the suppliers for different prices. We have already defined the supply curve right and the supply function. So, the supply curve is the quantity supply for different prices. So, its a locus of different quantity supply for different prices. So, that was for the individual firm or individual producer.

Now, for the market as a whole what do we do? We have to add the quantity supply for different prices. Let say the world oil supply. So, we know that OPEC is the major supplier of oil. But once again it is not the single supplier or monopoly because OPEC alone cannot supply all the market demand. Therefore, there are non OPEC suppliers as well.

So, what will be the total world supply of oil? That will be OPEC supply plus non OPEC supply. So, at each price we have to add the quantity supply by each of the firm. So, market supply can be defined as the horizontal sum of each producers supply curve. So, that is basically the sum of all quantity supplied at a given price at a particular point in time.

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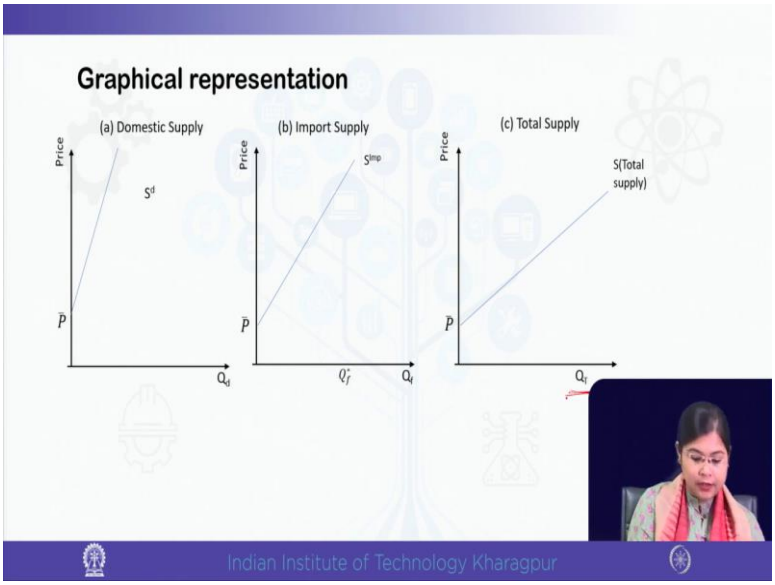

So, if we think of the example of say India's total supply of oil. So, as we know that our domestic demand is quite high, but our domestic endowment of oil or petroleum product is quite less. So, we have to import; that means, we have to buy a lot of amount of oil from abroad. So, import is what we buy from abroad. So, total supply of oil in the domestic market of India is sum of India's own domestic endowment or production plus the import supply.

So, here we have plotted the domestic supply and import supply of oil and we get the total supply you can see. In figure a, we have shown the domestic supply of oil in figure b that's the import supply and in figure c we have added. So, what we have done at each price we are adding the quantity supply.

So, at each price we add the domestic supply, import supply to get the total supply. So, just the idea is same the way we derive the market demand. So, in a nutshell what we do? For market demand we add the total quantity demanded for each of the consumer in the market for various prices to get the market demand. For market supply same thing, we add the quantity supply of each individual producers or suppliers to get the market supply.

Once again you see in the horizontal axis we are referring to Q subscript T capital T; that means, total quantity ok and in the first figure Q_D is the domestic supply. In the second figure Q_F is the foreign supply or import supply. So, in the third figure in figure c that is

Q_T is the total supply. So, Q_T is equal to Q_D plus Q_F. So, that is how we derived the market supply.

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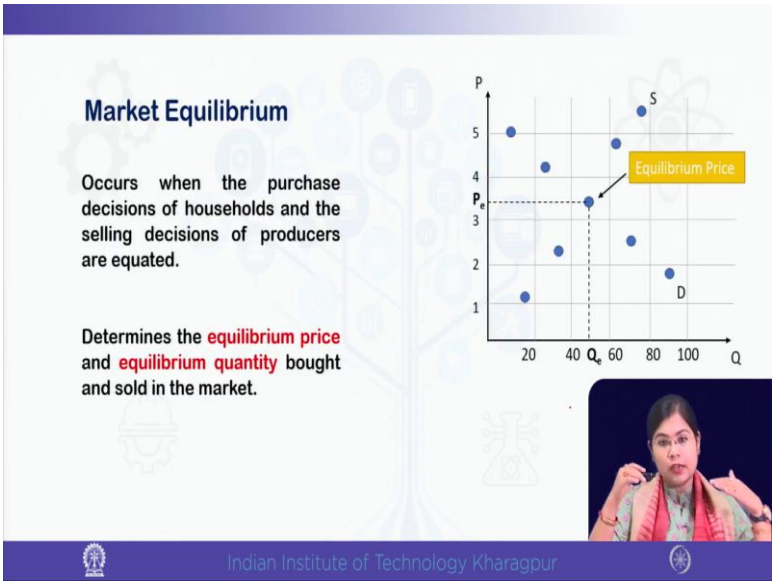

So, now that we have derived the market demand and market supply our purpose of studying this module 2 was to get the equilibrium; was to know how a market functions. By market we do not mean a particular geographical location or any online portal it is a mechanism where we need two parties, but they may not be meeting each other. But till we arrive at the equilibrium quantity transacted and we get the market price.

So, how do you do that? We put the market demand and supply together. So, we have derived just now the market demand which is shown in this figure; this capital D curve and this is the market supply. So, we are actually plotting not the curves, but different values of quantity demanded for different prices. Similarly we have also plotted the different quantity supply at different prices and we see that at price P_e the demand is equal to supply.

So, at price P_e quantity demanded is Q_e again quantity supply is also Q_e. So, we can say that the market clears at price Q_e and the resulting quantity supply quantity transacted rather will be Q_e. So, what is the equilibrium? Equilibrium is a situation where plans of all economic agents get realized.

So, we arrive at equilibrium when the purchase plan of the buyers match the selling decision of the sellers. So, we can get the equilibrium price and the equilibrium quantity transacted; transacted means both bought and sold. So, you see at price P_e from the demand schedule we can see that the consumers want to buy amount Q_e. Again from the supply schedule you can see that at price P_e the suppliers want to supply quantity Q_e.

Therefore at P_e, the plan of the buyer is to buy Q_e which is exactly matching the plan of the seller who has planned to sell supply Q_e therefore, there is no incentive for any economic agent to deviate. Therefore, equilibrium can be defined as a situation where plans of all economic agents get realized. So, that no one has an incentive to deviate from the equilibrium if it is an equilibrium.

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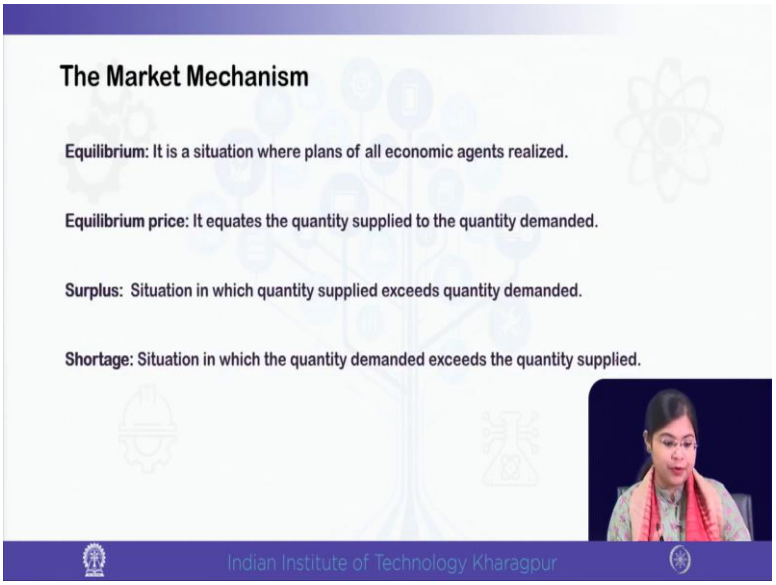

So, equilibrium price is that price where quantity supply is equal to quantity demanded ok. Now, if for some reason suppose we are out of the equilibrium.

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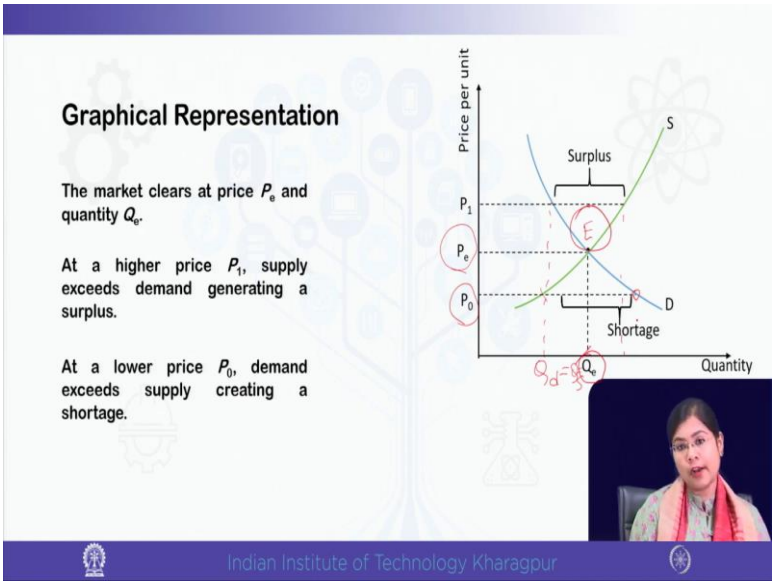

So, what will happen? We can show easily, that if for some reason we are out of the equilibrium you can show see this figure where we are plotting as usual price on the vertical axis and quantity on the horizontal axis. We have discussed it in detail because we are working with the inverse form of the demand and supply function.

Therefore we can see that this demand curve and the supply curve they are intersecting at point say E where price is P_e and equilibrium quantity is Q_e therefore, at price P_e equilibrium price quantity demanded Q_d is equal to quantity supplied Q_s is equal to Q_e. Therefore, this is the equilibrium or we can also look at from the inverse point of view the Marshallian point of view that at quantity Q_e, the consumers want to pay the price P_e.

Similarly, what is the minimum price that the producers need to supply amount Q_e? We can again see that the producer needs the price P_e to supply amount Q_e therefore, the maximum willingness to pay price for the consumers is P_e for the quantity Q_e which is exactly equal to the minimum supply price that is required for the producer to sell the product in the market.

So, at output Q_e, the demand price P is equal to the supply price P_e. Therefore, we get the equilibrium where the decisions of all economic agents both the buying decision of the consumers and the selling decision of the producers are matching therefore, we get the equilibrium at point E.

Now, if for some reason if we are out of the equilibrium we can see that the plan of one of the parties will not be realized. What happens, if for some reason suppose price is if we consider any price above the equilibrium price. So, if we refer to the diagram suppose we consider any price P_1 above the price equilibrium price P_e.

So, what happens? We know. If price increases now we have already studied the laws of demand and supply right. So, at higher price what happens? By law of demand quantity demanded will fall. So, you can see that at higher price quantity demanded is less and if price increases by law of supply quantity supply increases.

So, therefore, at price P_1, since price has increased the suppliers are motivated they have greater incentive to supply more at a higher price, but if price increases by law of demand quantity demanded falls. So, at price P_1 producers are willing to sell more whereas, the consumers are willing to buy less.

Therefore what happens? At price P_1, the there is a surplus right. Because there is some an excess quantity being sold means the producers are willing to sell some excess quantity, but the consumers are not willing to buy that much because price has increased. At a higher price quantity demanded falls. So, there arises a surplus situation ok.

Now, if there is no intervention by any third party or by government. So, the market forces can clear the out of equilibrium situation if there is surplus so what will happen? The producers would like to sell. Surplus means there is some unsold quantity; producers are willing to sell more than what the consumers are willing to buy.

So, what will happen? That will lead to competition among the producers they will be willing to sell more they will offer a lower price. So, if there is no intervention by any third party. If the market is left to the market forces of demand and supply alone therefore, price can fall ok. Similarly, if we consider any situation below the equilibrium price at a lower price P_0 what happens? We have by law of demand and supply we can say that at a lower price we know quantity demanded will be higher.

But at a lower price the sellers are willing to sell less therefore, demand is greater than supply at a lower price. So, what happens? There are unsatisfied consumers in the market consumers want to buy more than what is being offered by the sellers. So, there arises a

shortage situation because the consumers are willing to buy much more than what the producers are actually putting in the market ok.

So, if there is a shortage situation and again there is no government intervention. So, what will happen? This excess demand. So, shortage is nothing but the excess demand. So, this excess demand will push up the price because the consumers will try to buy the good they want to pay more price may increase.

However, if a third party intervenes like suppose the government can floor the price. So, then the price will be maintained, but the government has to then take associated policies. For example, often we know that there are price regulations. Say suppose some very necessary products like medicine, the government can floor the price can set the price at a lower level, but then shortage will arise. So, the government has to supply some excess amount and the government can also provide some incentive to the producers.

However we are not going into that detail. We are just looking what happens, if we are out of the equilibrium. So, you can see that for any price above the equilibrium price there will be a surplus situation ok, which may lead to excess supply or what we call surplus. Because at a higher price, the producers want to sell more and consumers want to buy less. Often we have this minimum wage regulation when the wage rate is maintained at a subsistence level.

So, this minimum wage regulation also leads to excess supply of labor or that is nothing but unemployment ok. So, the government can fix the wage rate above the equilibrium wage if the government thinks that the equilibrium wage is not sufficient to maintain a decent standard of living. So, then that will lead to unemployment that will force some of the unemployed workers to join the informal sector; however, we are not going into that detail because that is not the purpose of our course.

We are just studying what happens if the market is disturbed from the equilibrium ok and for any price less than the equilibrium price if price falls below the equilibrium price there will arise excess demand or shortage.

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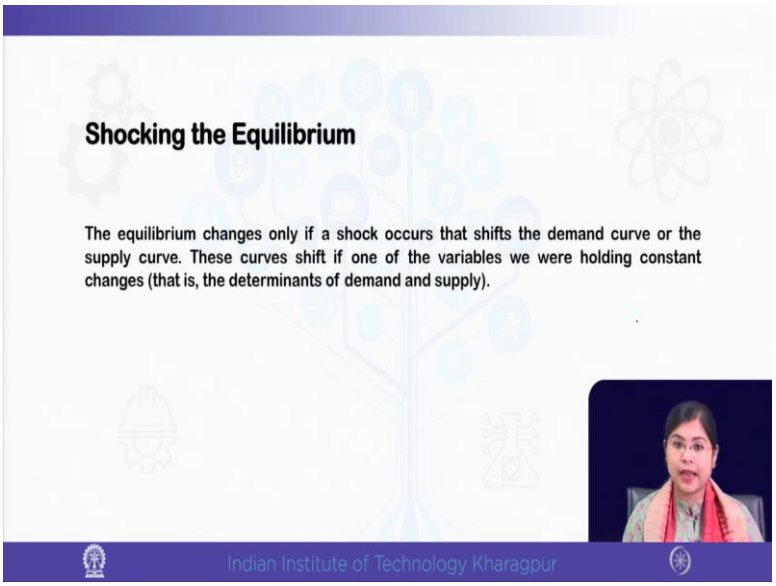

Now, with this understanding of the concept of market demand, market supply and equilibrium how the quantity and price gets determined in the market? Now, we have come to the situation where we can analyze the impact of major economic and non-economic events on the world oil market ok.

So, what happens to the equilibrium price and quantity if the determinants of demand and supply, if they change? Ok. If you remember we have already discussed what are the factors on which demand depends? So, we have discussed that quantity demanded depends on its own price, price of related good, income, taste or preference, weather expectation. So, if something other than own price changes we have already seen that the demand curve shifts.

Suppose income increases or decreases. So, we know that the demand curve will shift. If income increases for most of the good the demand curve will shift to the right. First there are some exceptions for which demand curve can shift in. Therefore, now we will see those things what happens when the other factors on which demand depends they change?

Similarly, we will also study, what happens if the other factors on which supply depends if they change? Because if you remember quantity supply is a function of its own price and what are the other factors? Technology, input price time; so these are the factors on

which quantity supply depends. So, what happens if these factors change? Or it can also happen that there can be changes both in the demand side and supply side together.

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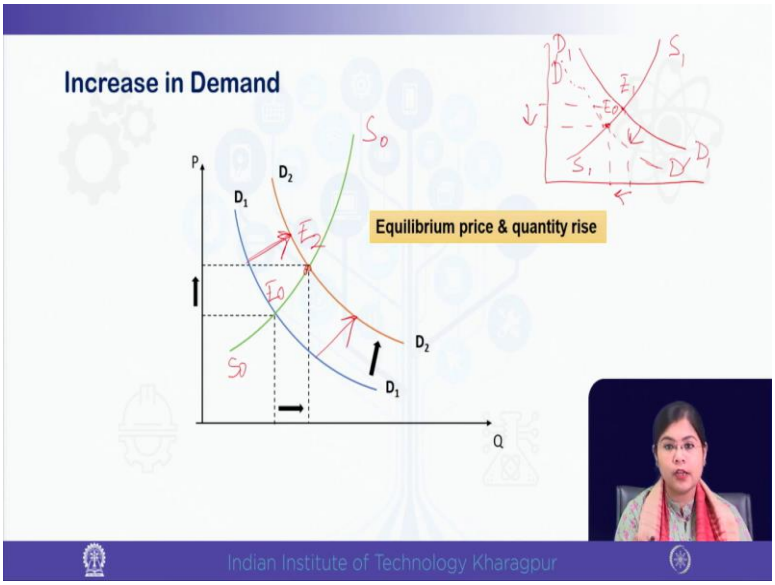

So, let us see some examples. Suppose we consider the example in such a way that we just introduce one change at a time. Say for example, you first see what happens if there is a change in demand. Suppose income increases. So, for most of the good if income increases or suppose the taste or preference changes in such a way that the consumer prefers the good more in higher amount.

So, the demand curve shifts. So, there will be rightward shift in the demand curve from D_1D_1 to D_2D_2 whereas, the supply curve suppose remains unchanged. So, what will happen? Now, we see that initially the equilibrium was at point E_0. Now, with the increase in demand due to increase in income or towards a more preferred choice for this good. So, demand curve shifts to the right. So, the new equilibrium is now obtained at point E_2 at a higher price and higher quantity.

So, with this we can also now see what will be the impact if demand falls? And we can now relate it with the pandemic. If you remember we have discussed that the sector wise use of oil is mostly for petroleum right. For sector wise use of petroleum is mostly for the transportation sector.

So, the lockdown was announced due to the pandemic what happened there was a sudden halt of international transportation which led to huge demand side shock ok. Because greater use of oil is still in the transportation sector, air transport, sea transport is mainly dependent on oil.

If so there is sudden imposition on restrictions of travel of goods and services of movement of people. So, that led to huge demand side shock for demand for oil. So, what happened? So, there was a sudden demand side shock and that led to a inward shift in the demand curve from D_1D_1 to say D dash D dash.

So, now we can see that initial equilibrium was at E_1. Now the new equilibrium is at E_0 with a lower price and lower quantity demanded corresponding to the earlier one ok. So, you see if there is a sudden demand side shock. So, demand falls price and quantity will fall.

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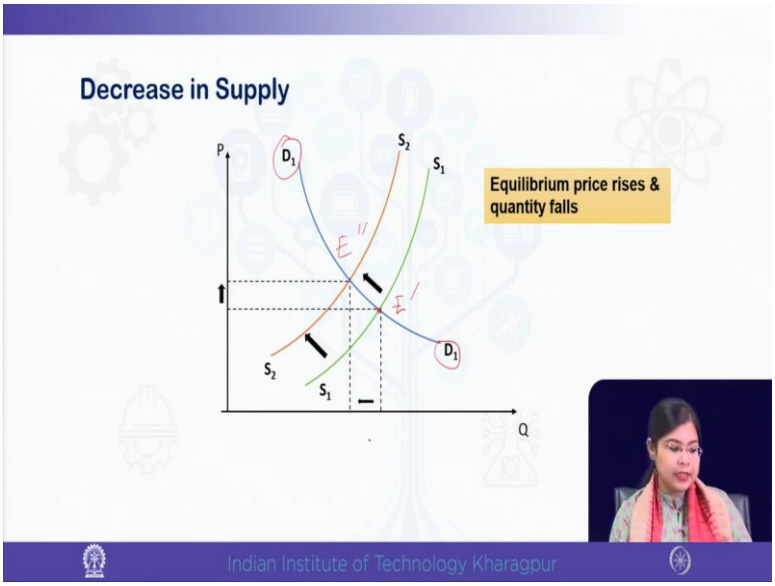

Next, we if we now keep the demand unchanged suppose the demand curve is fixed at D_1D_1, suppose the supply changes. We can consider several examples supply can increase due to technological improvement or supply can fall due to increase in input price or disruption in supply side like bad weather or even natural calamities or even say war.

So, if we take an example related to our context, suppose there is some war in the middle-east ok. So, what happens? Due to the gulf war we have already discussed the geopolitics and we have discussed the gulf wars. So, if there is a war in the middle-east; so, supply middle-east being a major supplier of oil the petroleum product. So, there is a fall in supply because at each price now quantity supply falls.

So, suppose there is a war in the middle-east therefore, the supply curve now shifts in. From S_1S_1 to S_2S_2. So, there is a leftward shift in the supply curve. Therefore, we can now see that the demand the equilibrium now shifts from E dash to E double dash with an increase in price and fall in quantity supply ok.

So, we see that with decrease in demand in this example the one we have drawn where we had a decrease in demand. So, with a decrease in demand quantity demand transacted declined and price also declined, but with a decrease in supply quantity transacted declines, but price increases ok.

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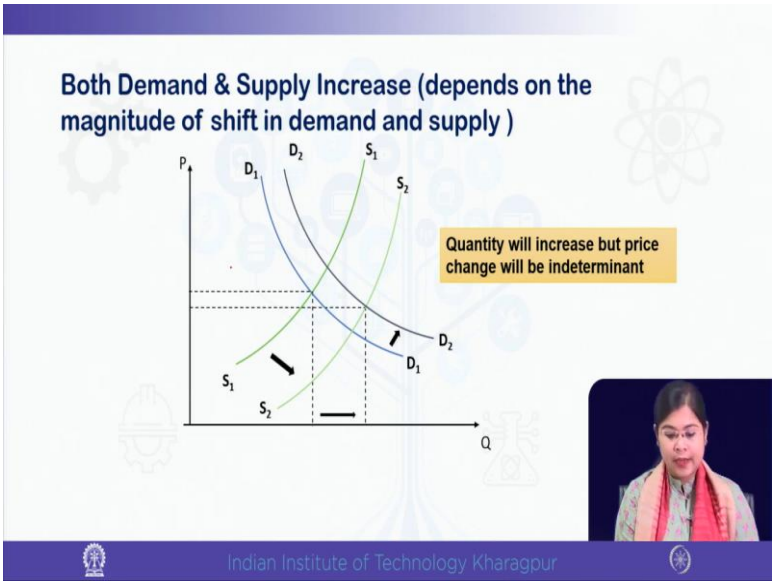

Now, we can change both the sides ok. So, we have studied the changes in demand and changes in supply separately. Now what happens if demand and supply they change simultaneously. So, now, what will happen that depends on the magnitude of the change. Because you can see that if we take this example of decrease in both demand and supply. So, due to supply fall, quantity is falling due to demand fall also quantity is falling.

So, if at the same time there is a demand fall and supply fall quantity transacted will fall, but what happens, if due to demand fall price falls. But due to supply fall price increases right. So that means, the impact of change in demand and change in supply on price is just opposite. So, what will happen to price if simultaneously both demand and supply falls? So, that we cannot say because that depends on the relative magnitude of change in demand and supply.

If demand falls more than the amount of supply fall. So, price will still be falling. If supply falls more than the fall in demand price will be increasing; the equilibrium price. If the demand and supply fall they are just same in magnitude. The extent to which demand curve shifts in is the same extent to which the supply curve also shifts in. Therefore, quantity transacted will fall, but price may remain unchanged. If the demand and supply changes are happening in same amount ok.

So, we need to know the exact magnitude of change to comment what will happen if both demand and supply are decreasing? Or you can also think of examples where both the both demand and supply are increasing. So, you can think of several examples will be doing assignments, interesting questions on this part ok.

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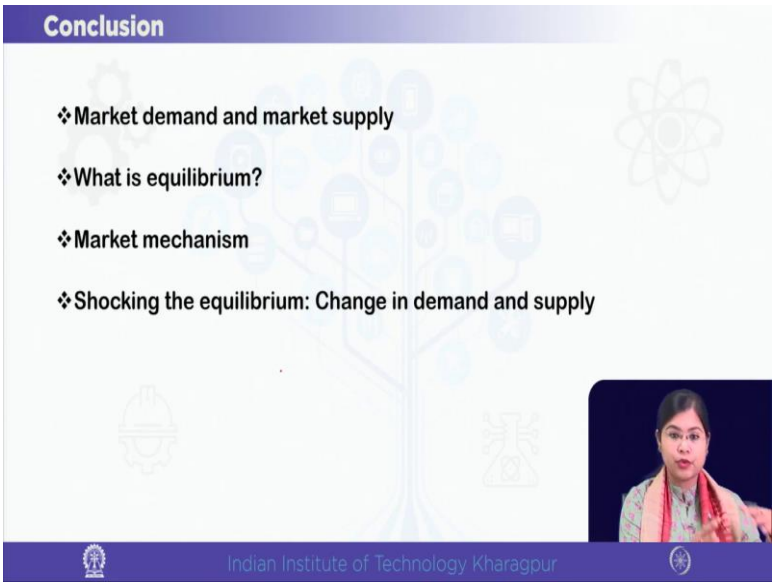

So, what we discussed in today's class if we just summarize our discussion? We started by deriving the market demand and market supply. Because, in the earlier lectures of this module we have studied individual demand we have studied individual supply. So, we

started today's class by deriving the demand and supply for the market. So, idea is same we add the quantity demanded for all the consumers in the market for different prices to get the market demand.

Similarly, for supply for getting the market supply we add the quantity supply by all the suppliers in the market to get the market supply. Then after getting the market demand and market supply we put the two together to get the equilibrium price and quantity. Then we discussed what happens if there is a deviation from equilibrium.

So, we saw that for any price above the equilibrium price there will arise a surplus; for any price below the equilibrium price there will be a shortage or excess demand situation and then we discussed how the equilibrium is disturbed if there is some change in either demand side or supply side or on both demand and supply side. So, if there are shocks how the equilibrium is disturbed?

How the price and quantity transacted are getting disturbed. So, these will be extremely helpful for us when we will be studying the price movement of oil over time and the impact of major economic and non-economic events on oil price.

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So, you can follow any standard microeconomics book for this part.

So, thank you very much, I hope you found the discussion interesting and we will see you in the next class.