Petroleum Economics and Management
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Module - 03
Public Policies
Lecture - 13
Welfare Analysis

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 Petroleum Economics and Management. So, we are in module 3 where we are discussing about Public Policies. So, in today's class of lecture 13 in module 3 we are going to discuss about Welfare Analysis.

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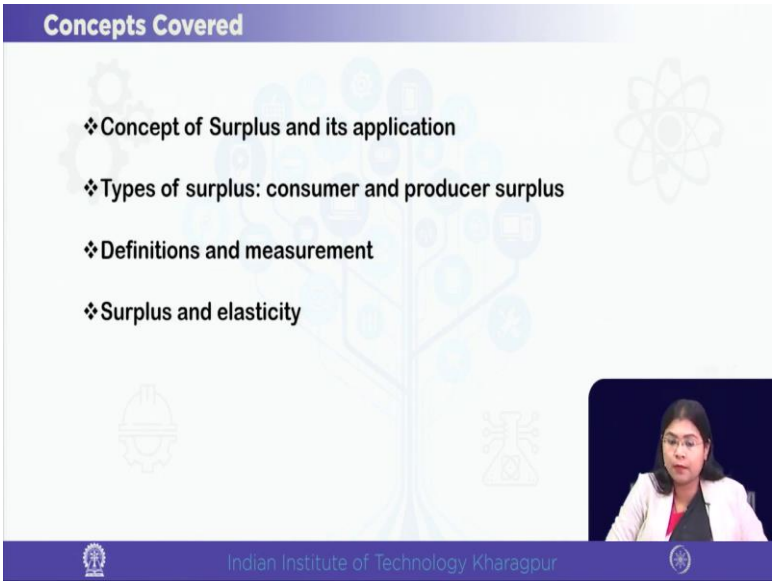

Now, if we remember in the last class, we already discussed what is the purpose or motivation of inclusion of this module 3 because in module 2 we have already studied the basic concepts of economics. But if you remember we have studied module 2 under a free market there was no intervention. So, we found out the market equilibrium by analyzing first the individual demand and then market demand and in the supply side we started with the individual producer and then we obtained the market supply.

So, we put the market demand and supply together, we arrived at the equilibrium. And we also studied in module 2 that how an equilibrium will change if there is some kind of shock COVID 19 pandemic or the Russia-Ukraine war. Now all lectures in module 2 followed under was a free market there was no intervention. So, the market was left to the forces of demand and supply.

However, in reality we do see lot of intervention. Especially, it is very important for our course because we have already studied the importance of taxes on the petroleum products. We saw not only for the developing countries like India and China even for the OECD countries the high-income countries like France and Germany also a huge amount of revenue comes from tax.

And we saw that the retail price of petroleum if we distribute into crude oil price, tax and the industry profit margin, we saw that is very high amount is due to the high amount of tax rate. So, that is one of the reason of high retail price of petrol. So, with this in motivation that petroleum is a very reliable source of tax revenue collection for the governments across the world.

Therefore, we have included the module 3 where we are discussing public policies. And if you remember we also discussed that it is not only tax is not only a good source of reliable source of revenue collection, but there are environmental gains also. So, we need to know how the tax rates are decided. Before that we need to have some elementary concept of welfare analysis.

How do we measure welfare? So, in today's lecture we are going to discuss how do we measure welfare. The standard measure of welfare in economics is given by the concept of surplus. There are two types of surplus consumer surplus and producer surplus. So, we will start our class by defining consumer surplus for an individual consumer and then we will discuss how do we measure the consumer surplus for the market as a whole.

So, we will discuss it both intuitively and then graphically and how do we measure it we give the exact formula. And then we will go to the producer side how do we measure producer surplus for an individual producer and for the entire market. Now coming to the market will then add the consumer surplus and the producer surplus and we will see that what is the total surplus in the market.

And then we will also find out the relationship between consumer surplus and the price elasticity of demand and how producer surplus also varies with price elasticity of supply.

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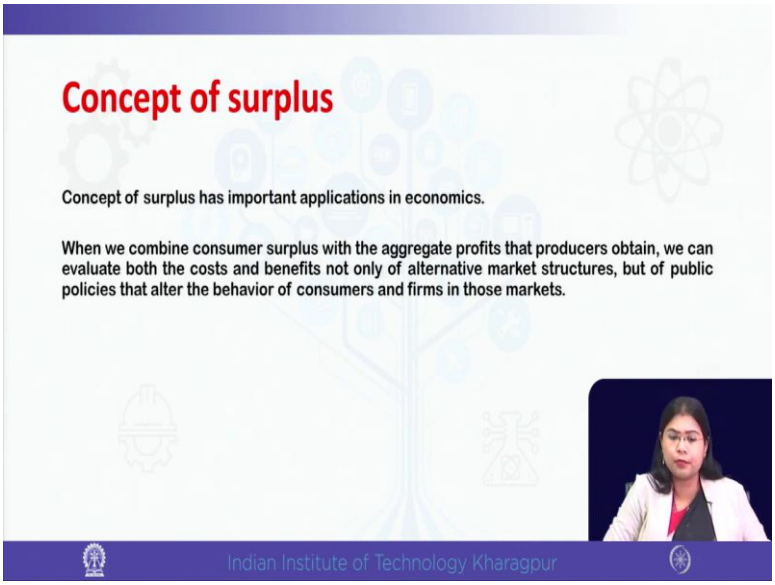

So, this is how today's lecture is organized. So, let us first start with a very important concept of surplus. So, in economics the concept of surplus has wide application. Because whenever we want to check any public policy any intervention by any third party like government or any other regulatory body like say for example, world trade organization in the context of in the international market.

So, we need to compare the pre intervention and the post intervention situation. So, for that the standard measure used in economics is given by the concept of surplus. How the surplus changes in the pre and post intervention period? Not only that we also use the concept of surplus to see the inefficiencies or welfare loss arising due to imperfect market.

As we proceed, we will see that the surplus is highest in perfect competition. In imperfect competition there will be loss of welfare. So, for that also we need the concept of surplus both consumer and producer surplus. So, if we deviate from perfect competition the how welfare is losing in other type of markets. And the degree of loss of welfare will depend on the extent of market imperfection, ok.

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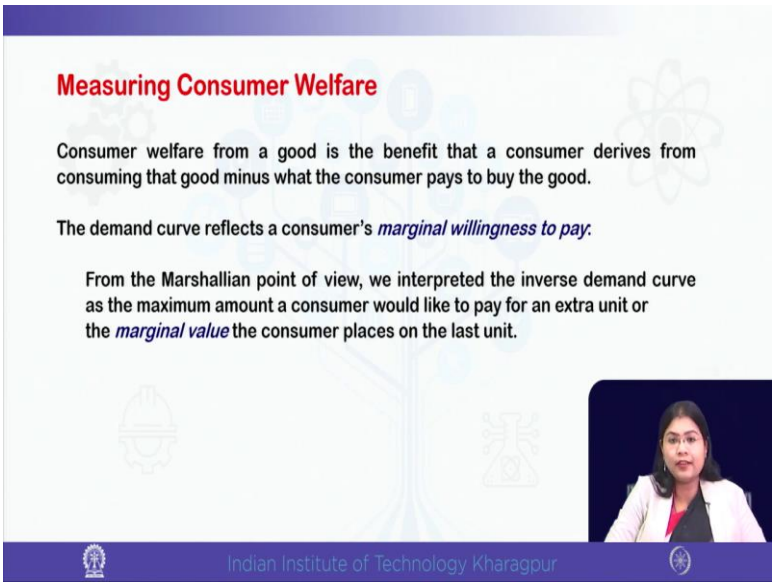

But in our purpose of the petroleum economics and management course we will be more focused towards the public policies, how government intervention can influence the surplus. So, we will be discussing about various types of policies like price policies and also quantity policies. So, first and foremost let us study what do we mean by consumer surplus, ok.

So, if we are buying a good, as if you remember we have already defined the demand function from the inverse or the Marshallian point of view. So, the inverse demand function tells that it is the locus of different maximum willingness to pay prices for different quantities by the consumer; that means, what? For each quantity that we want to buy all of us have a maximum willingness to pay price, that may not be the actual price.

But we have some maximum price that we are willing to pay to buy that amount that is just a notion by the consumer. That is different from the market price. So, if the maximum willingness to pay price is greater than the actual price then we can say that the consumer is enjoying a surplus. So, this is basically the consumer surplus is the difference between the maximum willingness to pay price and the equilibrium price, ok.

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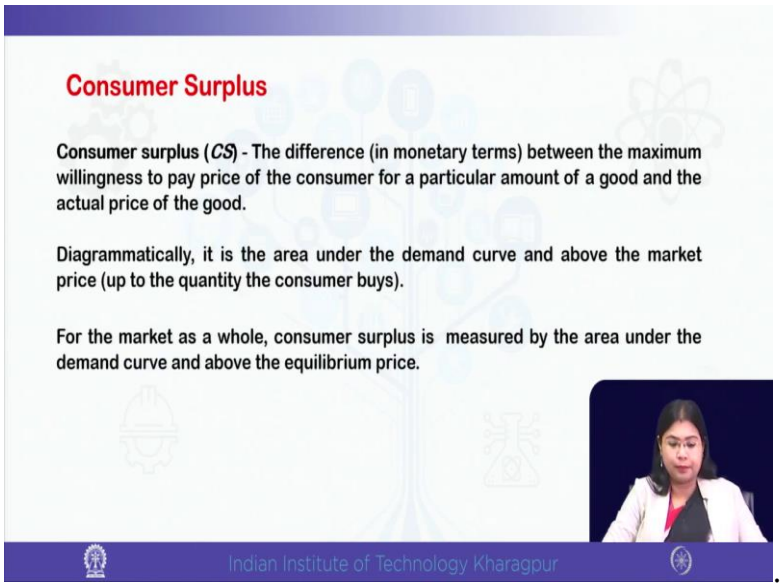

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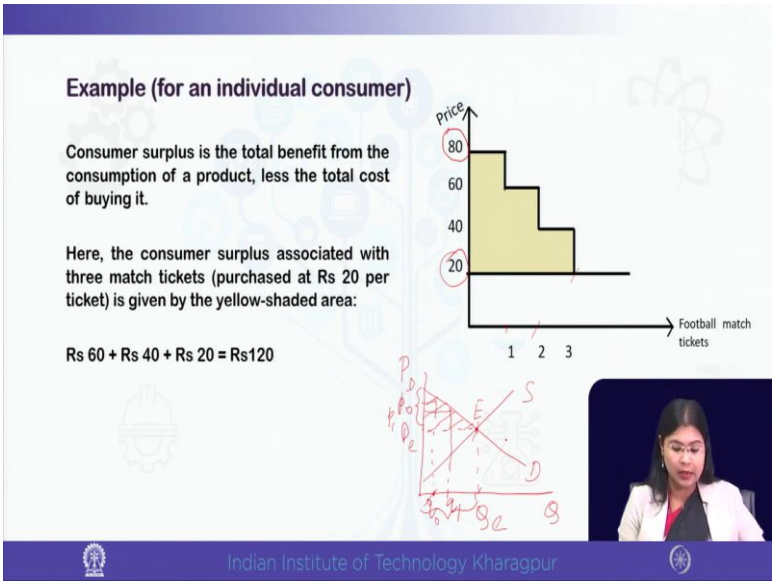

So, if we take some simple example of suppose going to some cricket match or football match some sports event. So, suppose like the World Cup football. So, there will be huge craze for tickets. So, suppose we plot the price and quantities there are some hypothetical values we can consider the price in 1000 and the quantities plotted in the horizontal axis. So, we can see that say for the first unit say the consumer wants to pay a very high price, ok.

So, but the actual price may be different. Suppose the actual price is given in 20 units terms. So, unit can be in 1000 also. And the maximum willingness to pay a price we can see over here is very high 80 units. So, it can be in 1000 and the actual price is 20 so, for the first unit. So, that means, for the consumer who wants to buy one football match ticket wants to pay a very high price than the equilibrium price or the market price.

So, we can say that this difference between 80 and 20 can be the surplus enjoyed by the consumer willing to buy only 1 unit. Now you see if the consumer wants to buy more units say 2 units or it can be another consumer also, he or she may be willing to pay 60 in units per unit price for these 2 units.

So, for the that consumer who wants to buy more. Now the per unit surplus is also greater it is now 60 minus 20. So, that consumer is also enjoying 40 units of surplus for each unit of ticket purchase. So, in this way we can see that all the consumers are enjoying a surplus till the last consumer who wants to buy say 3 units and his or her maximum willingness to pay a price just coincides with the market price.

So, we can say that the consumer who is at the margin suppose we bring the demand and supply curve over here. So, you already know we have studied that the price is formulated in the market by interaction of demand and supply. So, if we plot the total quantity say capital Q. So, we can find out this equilibrium price and quantity.

So, that means, the consumer who wants to buy the amount Qe we can see that for that consumer the maximum willingness to pay price is Pe which is just same as the equilibrium price. So, that consumer is not enjoying any surplus, but all the consumers who are in the range of 0 to Qe they are enjoying a surplus. Because suppose a consumer who wants to buy suppose q0 amount say q0 amount that consumer wants to pay a price say p0.

So, p0 minus Pe is the benefit or the surplus enjoyed by the consumer. Because it is as if the consumer wants to pay more, but is actually paying less. So, the consumer is gaining. So, you can think of lot of examples. So, if we could not have a breakfast. So, we will be very hungry for our lunch. So, we will be willing to pay a very high price for a lunch meal. So, that consumer may not be paying that very high price actually because the market price can be less.

But this very high willingness to pay a price and the gap between the gap of that with the market price will be the surplus enjoyed by that consumer and suppose even after having one lunch meal the consumer is still not completely satisfied. So, the consumer wants to have another lunch meal, but for the second unit the maximum willingness to pay price may not be the same.

Because the consumer may be still hungry, but maybe to a less extent because he or she already had a one plate of lunch meal. So, suppose for the next unit then for unit say q1 the consumer's maximum willingness to pay a price is p1 which is still greater than the equilibrium price Pe. So, the consumer is still enjoying a surplus given by the difference between p1 and Pe, ok. So, in this way, we can find out the surplus.

So, you want to pay a very high price, but you are actually paying a low price. So, as your willingness to pay price is high you are enjoying more and more surplus. So, the consumer who is at the margin is not enjoying a surplus because for that consumer the maximum willingness to pay a price is exactly equal to the equilibrium price.

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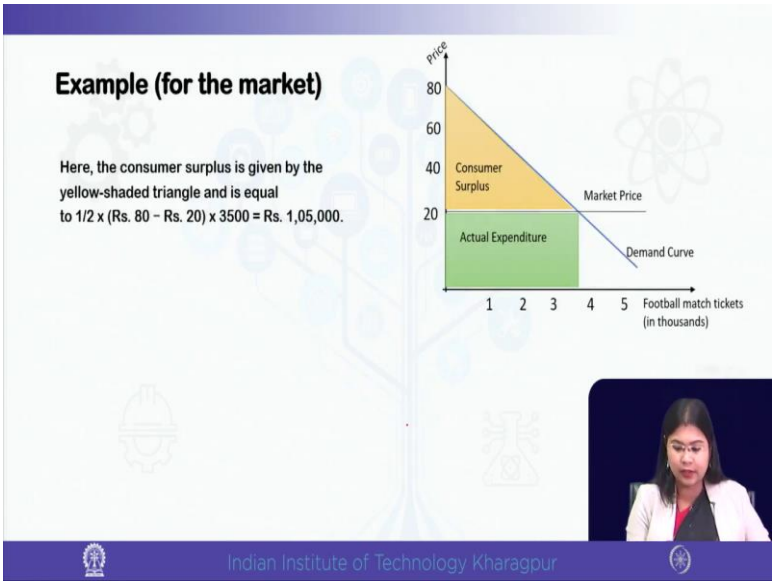

So, in this way, we can derive the consumer surplus for all the consumers in the market. So, here for an individual consumer, we see that we add up the difference between the maximum willingness to pay a price and the equilibrium price for all the quantity of consumption till the equilibrium is arrived.

So, here it is like a step like function, but when we have all we are considering all consumers in the market with different maximum willingness to pay price. So, the demand function will be a smooth a downward sloping line as long as law of demand is holding.

So, then what is the consumer surplus? So, graphically we can see then consumer surplus will be given by the area below the demand curve above the equilibrium price. Why? Because from the Marshallian point of view, the inverse demand curve can be considered or interpreted as the marginal value curve. Because it tells that if you want to buy a good how much you want to pay.

And by law of demand, you will be willing to buy more if the price falls, right? So, we can interpret the demand curve as the marginal value curve. So, the area below the demand curve can be interpreted as the value of the good, ok. So, graphically we can say that if we look at the figure that I have drawn we can see that if we add up the consumer surplus for each of the individual consumer.

So, we can derive the consumer surplus for the market as a whole which is given by the area below the demand curve above the equilibrium price. So, basically, it is the area of the triangle say DPeE, ok. Where D is the vertical intercept of the demand curve, ok. And point E is the equilibrium that occurs where we can see that the quantity transacted is Qe and the price is Pe.

So, the area below the demand curve above the equilibrium price which is given by the area of the triangle DPeE. So, we can easily apply the formula for which we use to calculate the area of the triangle to get the consumer surplus. That is, we already know the formula that is half into the height of the triangle into the base of the triangle. If it is a linear demand function if the demand function is non-linear then also, we can calculate.

The method is same because it is the area below the demand curve above the equilibrium price, but then we need to integrate and we have the limits the lower limit is 0 and the upper limit is the equilibrium quantity. So, we have to calculate the area below the demand curve above the equilibrium price to get the consumer surplus, ok.

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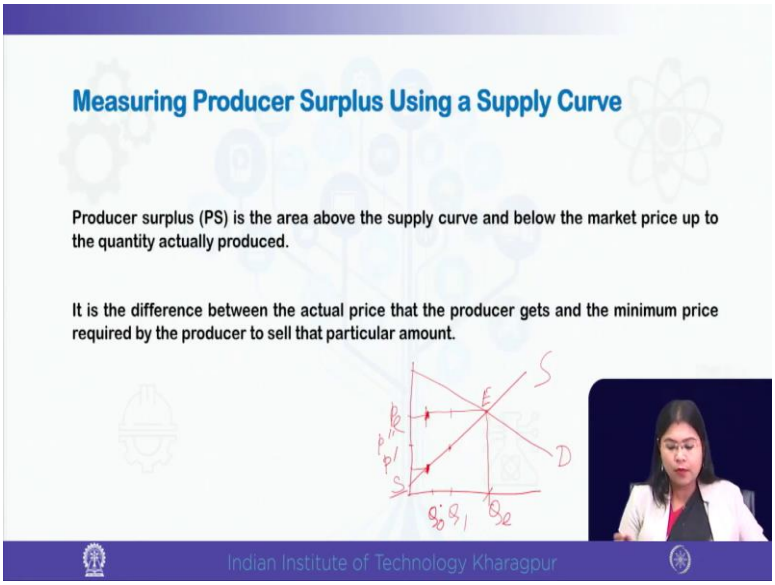

Now next concept is the producer side. In the producer side what is the surplus enjoyed by the producer? So, again you see we have defined the supply curve from the inverse point of view which tells that the inverse supply curve is the locus of different minimum prices that the supplier needs to a supply different quantities of the good, ok.

Because if you remember we have already defined to supply a good the producer needs a particular minimum price which represents basically the cost of production, but the market price can be higher, right? So, if we plot the demand curve and supply curve and this is the equilibrium price and this is the equilibrium quantity.

So, the supply curve is the locus of price quantity combination or from the inverse point of view to supply a particular amount. So, Q0 the producer needs to incur some cost of production suppose this is P dash and we can see that the market price is Pe. Let us say the price of petrol, ok.

So, the there is some cost of extracting petrol and then refining petrol, ok. So, the equilibrium price can be different from the minimum cost of supplying a particular amount of petrol. So, the petroleum exporting countries we already saw how much rent they enjoy. We saw in yesterday's lecture in the previous lecture that the companies the OPEC countries especially or the middle east countries they are hugely dependent on oil rents a large part of their GDP comes from oil rent.

So, this is because they have a lower cost of production given their endowment huge amount of endowment of good quality of oil. So, what happens is that the market price is much greater, ok. So, there is a minimum cost of production which is less than the market price therefore, the producer enjoys a surplus. So, this way we can see that to supply greater amount let us say Q1.

What happens? To supply more amount, the producer will require a higher price suppose to supply a greater amount Q1 the producer needs a higher price P double dash. So, the surplus enjoyed by the producer for the greater amount Q1 will be given by the gap between the equilibrium price Pe and the minimum price P double dash.

So, in this way, we can see that all the producers will be enjoying a surplus until the point Qe. So, at point Qe the producer who wants to supply output Qe. So, the minimum supply price is Pe which is exactly equal to the equilibrium price. Therefore, the producer who is supplying at the margin will not be enjoying any surplus, but for all the intra-marginal units the producers will be enjoying a surplus, ok. So, if we now add up what happens?

Just like we did for consumer surplus we can now tell that the producer surplus will be given by the area below the equilibrium price and above the supply curve. Because if you see the supply curve is nothing but it is a representation of the cost of production of the firm or a particular company. So, area below the supply curve can be interpreted as the total cost of supplying the good, ok. Therefore, the producer surplus for the entire market will be the area below the equilibrium price and the above area above the supply curve.

So, basically, graphically we can see that it is the area of the triangle SPeE where S is the a minimum supply price or that is the vertical intercept of the supply curve, ok. So, we can similarly use the formula of how we calculate the area of a triangle. So, for a linear supply curve, it will be just half into the base of the triangle and the height of the triangle. So, we can see that the base in both cases the consumer surplus and producer surplus the base will be calculated by the amount of equilibrium quantity.

And the height of the consumer surplus, the height of the triangle will be given by the gap between the vertical intercept of the demand curve and the equilibrium price and for the producer surplus the height will be given by the gap between the equilibrium price

and the vertical intercept of the supply curve. So, in this way, we can calculate the consumer surplus and producer surplus.

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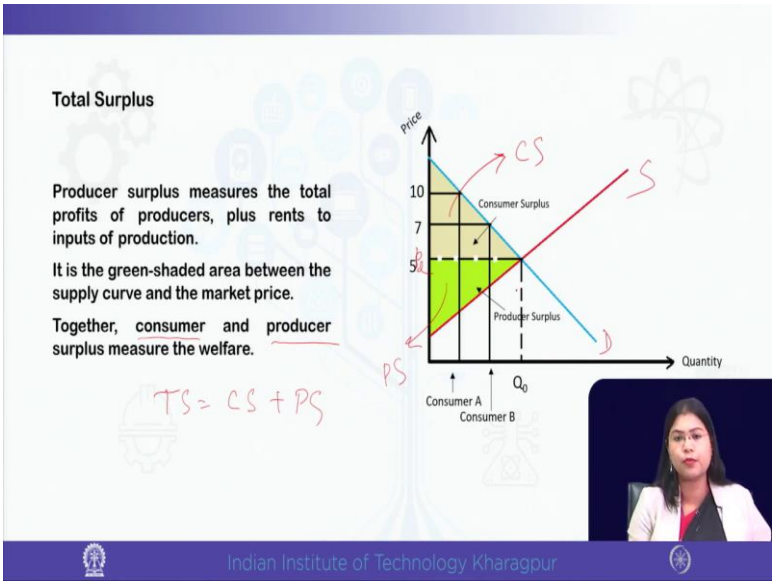

Therefore, now putting the two together we can say that the total surplus will be an addition of the consumer surplus and producer surplus. So, we can see in this figure we have plotted the price and quantity for different consumers and producers. So, basically, this demand and supply curve over here they represent the markets, ok. So, the market demand curve and the market supply curve and the equilibrium is arrived at say out price Pe and output say Q0.

This way we calculate the consumer surplus. So, this area is the consumer surplus area below the demand curve above the equilibrium price and the lower triangle this one is the producer surplus, which is the area below the equilibrium price and above the supply curve. So, the total welfare for the market will be the sum of the consumer surplus and producer surplus.

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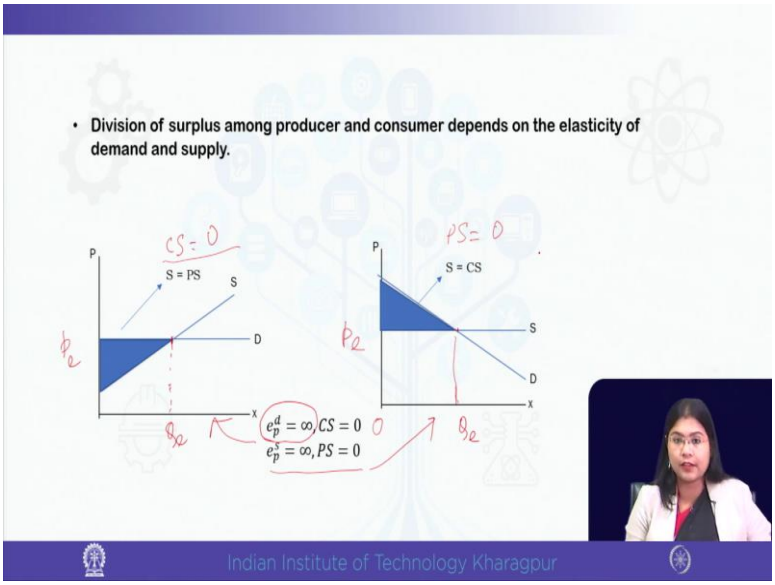

Now how this surplus is divided? Because in this figure you see the total surplus which is sum of consumer and producer surplus is more or less, we can see that the amount of consumer surplus is more or less very close to the amount of producer surplus. So, which may be an ideal case. Because the way we have drawn the demand and supply curves in this figure they are more or less having similar type of elasticity values in an absolute term, but they may not be similarly elastic.

Like for example, if we consider our case petroleum is very inelastic in demand. So, petroleum demand curve will be a steeper one. So, we can see that how the surplus will be divided among the consumers and the producers that will depend on the elasticity of demand and supply.

So, we have drawn some figures where we can see that how the amount of surplus will vary with elasticities of demand and supply. So, we can see that the division of surplus among the consumers and producers they will vary inversely with the elasticity. Suppose in the left-hand side figure we have drawn the demand curve in such a way that the demand curve is perfectly elastic. So, we have drawn a horizontal demand curve, a demand curve which is parallel to the horizontal axis.

So, here we know that in this demand curve, the elasticity is infinity. Now we can see that the entire surplus in this market will be the producer surplus, the consumer surplus here will be 0. Why? Because if we now bring the supply curve like the upward rising

supply curve, we see that this is the equilibrium. And what is the price? Now the price is Pe. Now how do you find out consumer surplus? We have to get the difference between the maximum willingness to pay a price and the equilibrium price.

But now we see that for any quantity from 0 to Qe, the maximum willingness to pay the price is also Pe. Therefore, the consumer surplus will be equal to 0. Because all the consumers are not enjoying any surplus their maximum willingness to pay price is exactly same as the market price or the equilibrium price.

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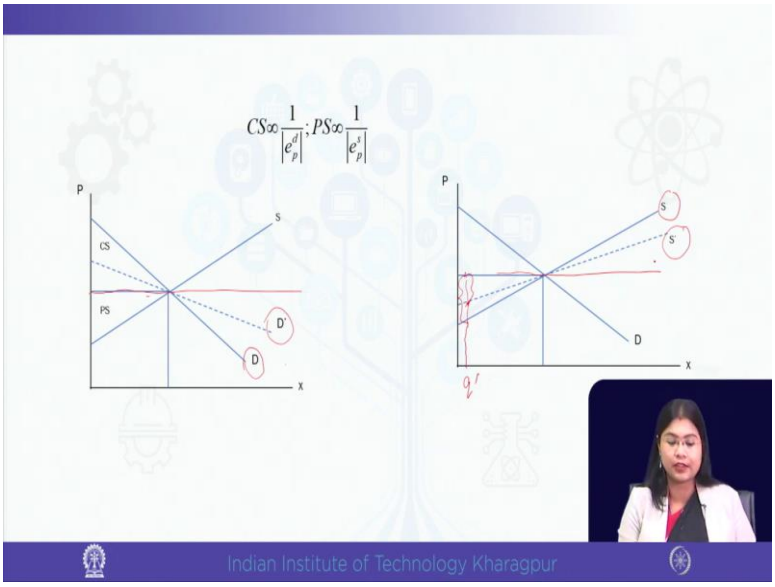

Therefore, we can conclude that the consumer surplus varies inversely with elasticity of demand. So, in this extreme case that we have plotted over here demand is perfectly elastic or infinitely elastic hence consumer surplus is equal to 0; that means, if elasticity of demand is less like in the case of petroleum products. So, surplus will be more.

So, we can see we have drawn different demand curves and we you see how the amount of surplus varies. So, if we consider this demand curve blue one, we see that the consumer surplus is high.

Now, if we consider this dotted one D dash, we see that this demand curve D dash is more elastic than compared to the original demand curve D and the extent of surplus will be less. And in the extreme case when we have this horizontal straight line demand curve. So, that eP is infinity, ePD the own price elasticity of demand is infinity consumer

surplus becomes 0. So, we can conclude that consumer surplus varies inversely with elasticity of demand.

We will see the importance of this finding when we study tax policies or other type of government intervention. In similar fashion, we will also relate the producer surplus with the elasticity of supply. So, here in this figure we have drawn the extreme case where elasticity of supply is infinity, ok. So, this one corresponds to this figure in the right-hand side. So, here the supply curve is parallel to the horizontal axis elasticity of supply is infinity.

So we can see that the producer surplus over here is 0 and the total surplus of the market is exactly equal to the consumer surplus. Why? Because here what happens if we bring the demand curve and we see the equilibrium price quantity. So, this is the equilibrium quantity Qe and the price is Pe. So, what is producer surplus? That is the difference between the minimum price and the equilibrium price.

Now, we see that for any quantity 0 to Qe the minimum price required by the producer to supply the good is exactly equal to the equilibrium price. Therefore, there is no gap between the minimum price and the equilibrium price. Therefore, the producer surplus is equal to 0. But the consumers are enjoying a surplus. Therefore, the t otal surplus is equal to consumer surplus.

Hence, we can conclude that producer surplus varies inversely with elasticity of supply. So, in this figure here we have drawn different types of supply curves who are varying with respect to their elasticity. So, you can see that this supply curve S is relatively inelastic compared to the supply curve S dash and the extent of producer surplus is greater because the gap between the actual price and the minimum price is greater in supply curve S compared to supply curve S dash.

If suppose we consider a particular amount suppose q dash, ok. Therefore, we see that corresponding to the supply curve S dash which is more elastic as compared to S the producer surplus will be less. And if we now take the extreme case where supply is perfectly elastic. So, producer surplus will be equal to 0 and total surplus is equal to consumer surplus. So, we see that producer surplus varies inversely with elasticity of supply.

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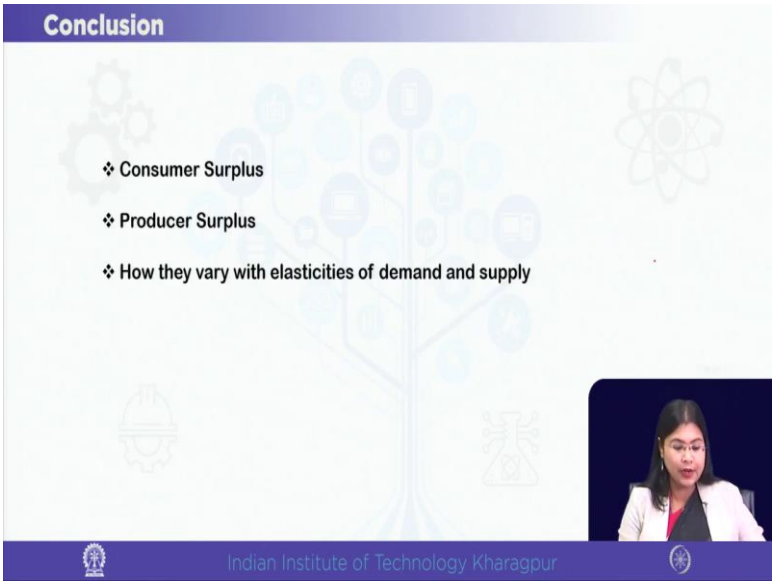

So, in a nutshell if we summarize today's class, we discussed how we measure welfare. This is very important whenever we are discussing any deviation of market from perfect competition and not only that this is very important for analyzing any type of intervention by any third party be it the WTO or any international body or the governments in any country.

And for our purpose we will be discussing in depth about petroleum taxes. Therefore, the concept of welfare is very important. So, in today's class we learnt that welfare is measured in terms of surplus which is sum of consumer surplus and producer surplus. So, we discussed the concept of consumer and producer surplus intuitively and graphically.

And then we found that the amount of surplus varies inversely with elasticity. So, consumer surplus varies inversely with elasticity of demand and producer surplus varies inversely with elasticity of supply.

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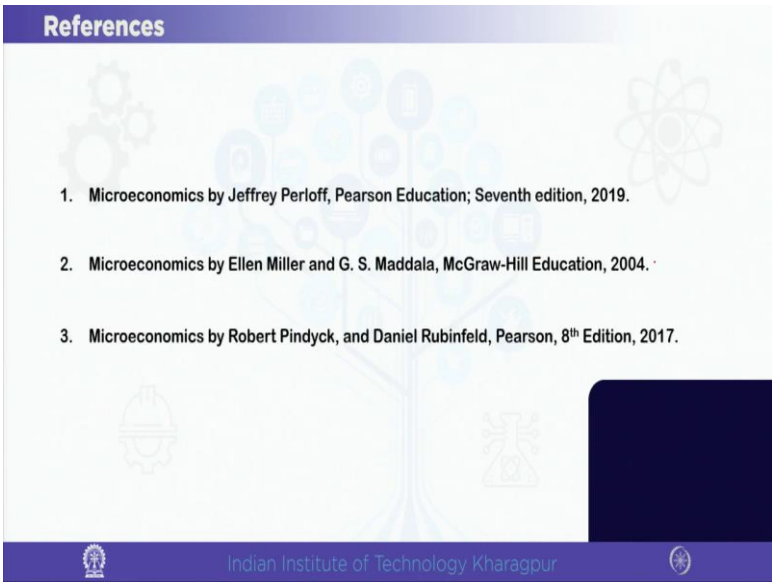

The for in the next class now we will be discussing in depth about the public policies, how the surplus will change when there is any intervention by any third party. So, one can follow any standard Microeconomics book for studying the public policy part so.

Thank you very much, see you in the next class.