**Introduction to Market Structures**
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Module 4: Monopoly
Lecture 14
Price Discrimination I

Hello. Welcome to my course: Introduction to Market Structures. Today we will do the remaining portion of Monopoly and we will start price discrimination. So, we were doing inefficiency in monopoly.

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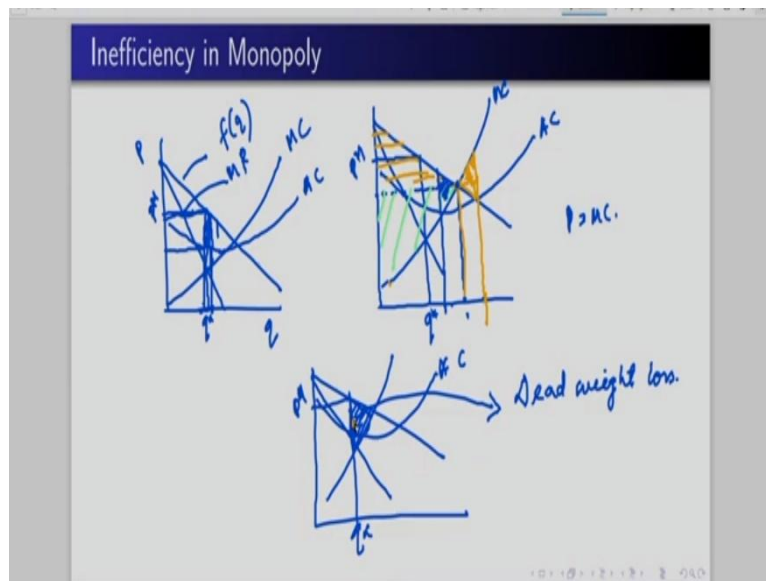
So first, we will see that suppose, this is the output in this axis and this is the price and this is the demand curve and this is suppose the marginal revenue curve and this is the marginal cost curve. So, monopoly output is this and the corresponding monopoly price is this and suppose the average cost is this, okay.

So, the monopoly profit is this rectangle, okay. Now, suppose a firm instead of producing this, if it produces here, what happens? We know it is not a profit maximizing output. We have done that but, what we can see is this that if it produces this much, then and suppose, it knows a consumer who is not able to buy at this price, but who can buy if the price is less.

So, it takes that consumer and it charges this whole amount and to get this much amount, so this amount is charged. So now and the price for or the cost that the monopolist is bearing is only this much because fixed cost is already borne and this is the total variable cost, this region. So this much is amount charged by the monopolist. So, what is happening? So, this consumer who is not able to buy at this price now, can buy because this is the market price.

Those who can buy this good at this price they are buying and they are buying some amount, okay.

So, the total amount is this q star. Now, the monopolist knows few consumer who cannot afford this good at this price and for them and suppose the monopolist can distinguish between who can afford this price and who cannot. So, there are many assumptions and then monopolist can charge this region as the price, so this, whole amount for this amount of output, so this consumer will pay this and this consumer will get the good and this much extra monopolist is getting and this much is the cost that the monopolist is bearing. So, this must surplus.

So, what we can do? So already those consumers who were buying at this price, they are getting it and there are some additional consumers are getting it by paying this much amount, okay, but they are not earning any consumer surplus because they are this whole amount is being paid, but the monopolist can earn surplus like this.

So, what is happening? Now here, through this construction, we can show that the monopolist outcome is not a pareto optimal. Why? Because here, we have kept the level of satisfaction of the consumers same because already those consumers who were buying this good were buying at the same price. Some additional consumers are getting this good and they are getting it in such a way that they are not earning any consumer surplus, and the monopolist is earning some extra surplus.

So, we can keep the satisfaction level of all the consumers at the same level and as the monopoly, but we can make the monopolist better off. So that is why the monopoly outcome is not bad at all at the optimal. Okay. So here you can see this whole region so we can go on doing like this.

So, like take this. This is the monopoly price and suppose this is the prices AC, and now suppose the price is this, okay. So, the monopolist is selling at this price. If this is the case, then what is going to happen? Total surplus that the monopolist will get, is this region, right? and total surplus that the consumers are going to get because they are going to pay this much is this, okay. Now, if you produce any output more than this here, we know from the argument that we have done in the case of perfectly competitive here what is happening, this much is the additional cost and this whole triangle cannot be this amount is the losses that they are A is going to make.

So, at this outcome, this output we can see that the surplus total surplus that is a consumer surplus, and the producer surplus is getting maximum, because if it is less than this, if it is less here, then we can move in this direction and make this surplus, which is sum of consumer and producer but if you produce more than this, then we make a loss of this amount. So, at this amount, the social welfare is maximum. This, we have done. Now here, if we take the case of monopoly, price is this, output is this.

So, this amount is not received by either the consumer or the producer. So, this is the lost surplus. So, this amount is called dead weight loss. So, in a monopoly, there is always going to be inefficient outcome because there is always some dead weight loss and in through this argument, we can also argue that the monopoly outcome is not a pareto optimal outcome, okay, and here we can from this, we can show that it is not social welfare maximizing.

So, there is a problem of inefficiency here because this dead weight loss, this triangle or this region is this surplus is not going to the consumer and the producer which they can, if the pricing is the price is equal to marginal cost, then this is going to be the price and this is going and the output is this. So, this whole amount is going to be this yellow amount is going to be the consumer surplus and this green amount is going to be the producer surplus, but which is not the case if there is a monopoly. So that is why there is a problem of inefficiency in a monopoly.
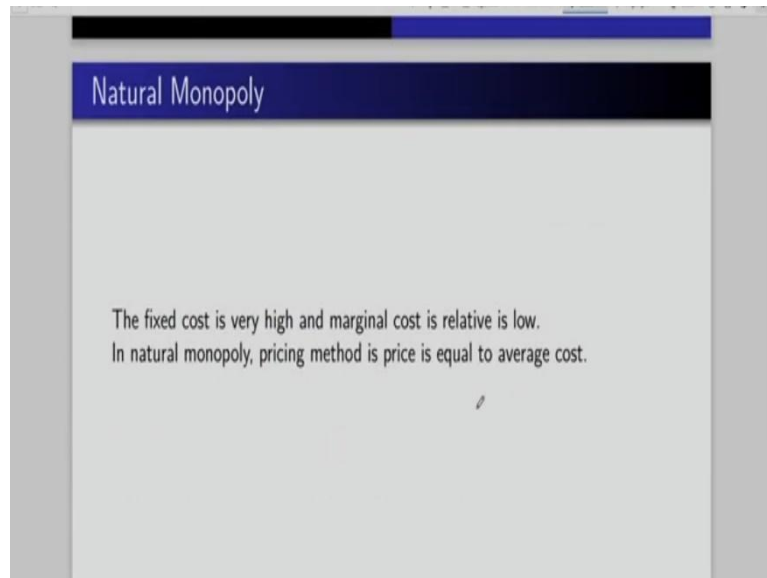
Next, we will do a special type of monopoly that is called a natural monopoly. A natural monopoly and the monopolist whose fixed cost is very high. The moment fixed cost is very high. It means that the average cost will take a different shape and the marginal cost is relatively low, not that high. So, we will say see. This is the situation.
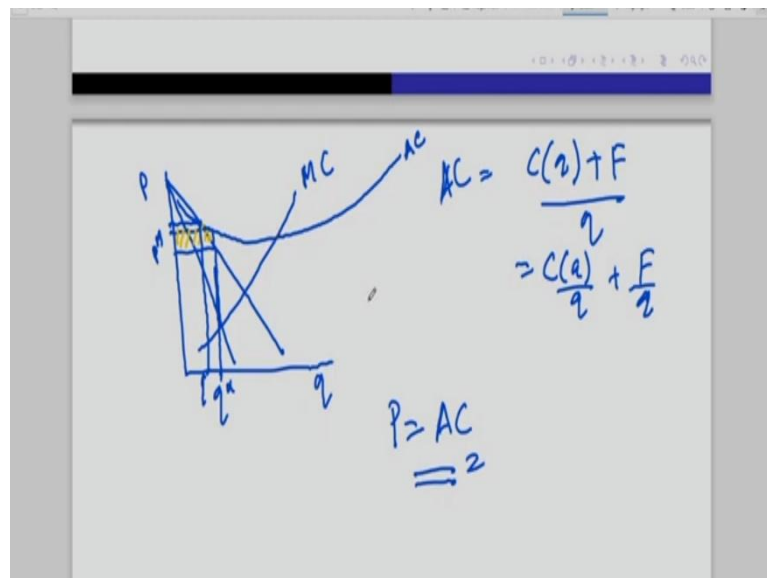
This is the output, price, okay, this is the market demand and this is the marginal revenue and suppose this is the marginal cost. So, monopoly output is this and the monopoly price is this. Now, suppose the fixed cost, average cost is what? Average cost is this- $AC = \frac{c(q)+F}{q}$. Now if this F is very high, then we may have a situation like this. Average cost is very high.

So, at this monopoly price, if the monopoly uses the same pricing method that is price, the output is marginal revenue equal to marginal cost, and the marginal cost should be upward sloping at that output, and to that output corresponding price from the demand curve gives us the margin monopoly price. Now here monopoly if uses this produces this output and say this price is going to make a loss of this rectangle, this yellow coloured rectangle.

So, this then the monopolist should not produce and this generally arises in the case, when the fixed cost is very high. That means the set-up cost is very high or like the case of electricity or the case of water treatment plant, or like those power production plant. All these things has very high fixed cost.

So, they may so even a monopoly may not be profitable. So here, what they do, they use the average pricing method. So, the price is equal to AC. So, at this point so firms produce this much amount of output in this case and the so it is they are making normal profit. That is profit is equal to 0 in this case.

So, this is the pricing mechanism for natural monopoly and natural monopoly is common in certain sectors like railways you can say it is a natural monopoly or you can say electricity power supply or the water treatment thing. Those kinds of things, or even a huge big iron and steel plant, all these have a characteristic of natural monopoly that is the marginal cost is relatively low sticking less here, but average cost is very high. Why? Because this fixed cost is very high. So, in this case, the monopoly pricing may not be profitable. So, the firm uses this method that is price is equal to average cost- P=AC.

Till now we have done all the optimization or what we have done, we have determined the monopoly output and given that output, we have found the monopoly price by from the demand curve. Inverse demand curve. Now, let us do this optimization in terms of price, that is suppose the monopoly first determines the price and then from that price using the demand curve or demand function we get the monopoly output.

So, in that case, we know the demand curve function is this- $\pi = D(p)p - c(D(p)) - F$ so this portion is quantity into price. So, this is the total revenue- $D(p)p$. So, this amount at price p quantity demanded at price p, quantity demanded is this- $D(p)$. We have specified it in the last class. So, the total quantity produced should be this.

So, this is the variable cost- $c(D(p))$ and this is the fixed cost- F . So, this is the profit function- $\pi = D(p)p - c(D(p)) - F$. This is the total revenue- $D(p)p$ and this portion is the total cost- $c(D(p)) + F$. Now, we optimize since we know these functions are differentiable. So, we find the optimal price by differentiating it with respect to P. That is the price like this and if we do this, we will get this expression- $\frac{d\pi}{dp} = D(p) + D'(p)p - c'(D(p))D'(p)$, right?

And from here, the first order condition, this should be equal to 0 and we get this equation- $D(p) + D'(p)p - c'(D(p))D'(p)=0$, and we solve this for this p and we get the monopoly price that is by solving this equation this and now, we substitute this monopoly price in this difference curve, and that will give us the monopoly quantity, okay. So, this is how and we will get the same thing.

So, let us now do some example and then things will be more clear. Suppose, the demand curve is this A minus p is equal to q- A–p=q. So here this is A is real number positive real number and P is the price, q is the output, market output and if we take this demand curve, then the inverse demand curve is this- A–q=p and the cost function is of this- $c(q) = cq + F$. So that means that the firms have CRS the constant returns to scale and we assume this- A>c.

Here, this F that fixed cost, we are getting, it is from the rent that we pay in the building and here we have assumed this portion, i.e $cq + F$ is like CRS, so you can think that the labour and capital are variable and so it is giving you a constant returns to scale from these two factors and the building or that plot of land is fixed and that is giving you a fixed cost, okay.

Why we have made this assumption? It will be clear from the diagram. Like if we take demand curve is like this, this is A and this is A, then the marginal revenue curve is going to be something like this, marginal cost curve is this. So that is why C has to be less than A. If C is greater than it will be like this.

So, the cost is always greater than the maximum price that the consumer is willing to pay. That is the A. So that is why we require this assumption, okay. So, in this case the profit function is this- $\pi = (A - q)q - cq - F$ A minus q, this is the total revenue- $(A - q)q$ and output it is producing is q and this is the variable cost- cq and this is the fixed cost- F, we get this. Now, we solve this.
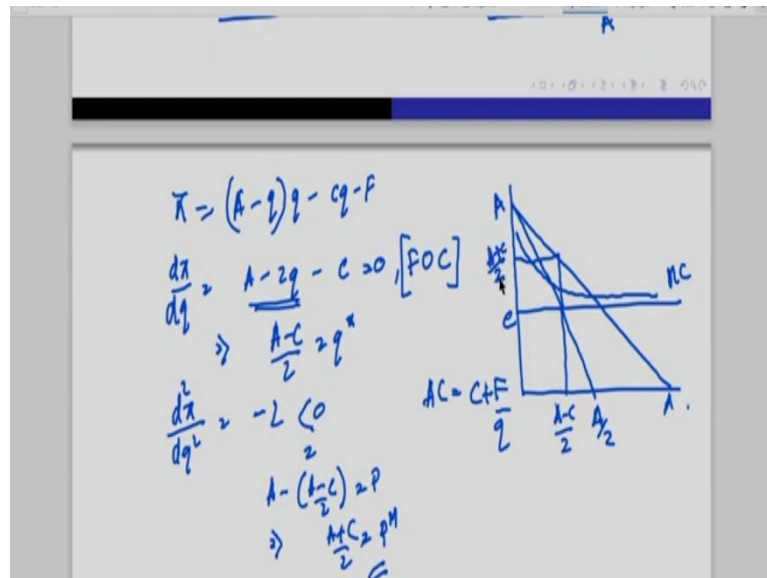
So, profit is A minus, i.e this- $\pi = (A - q)q - cq - F$, first order condition will give this- $\frac{d\pi}{dq} = A - 2q - c = 0$, first order condition will give this is equal to, so this means that this is the monopoly output- $\frac{A-c}{2} = q$, optimal output and if you take the second derivative you will see this is equal to 2, which is always less than equal to 0, i.e $\frac{d^2\pi}{dq^2} = -2 < 0$, okay. Now here, what you do monopoly price is this- $A - \frac{A-c}{2}$. This is the monopoly price-$\frac{A+c}{2}$. and how do we diagrammatically in this case.

So, this is the, so this point is A by 2. This is the marginal revenue curve, which is given by this portion. Marginal cost, which is this AC. Here AC is C by F by Q. So, it is something like this. This output is A minus C divided by 2. This monopoly price is A plus C divided by 2 this. So, this is the monopoly outcome in this case when we have constant returns to scale.

Now, let us do another example, we take the same demand curve that is the linear demand curve. So same inverse demand curve and suppose the cost function is of this nature- $c(q) = cq^2 + F$. So, if it is this nature, then the marginal cost is of this, right? because if the cost function is this, then the derivative of this is- $2cq$, so this is the marginal cost. So now the profit function is of this nature- $\pi = (A - q)q - cq^2 - F$ because this is the total revenue- $(A - q)q$ and this is the total cost-$cq^2 + F$. So, what do we do?

So, profit is A minus q, q this is the total revenue, q square minus f- $\pi = (A - q)q - cq^2 - F$. So, since every all the functions are differentiable, we take the first derivative and we get this- $\frac{d\pi}{dq} = A - 2q - 2cq$. This is the marginal revenue-. This is the marginal cost equal to 0

at first order condition or the optimal point, i.e $\frac{d\pi}{dq} = A - 2q - 2cq = 0$. So, we get this is

equal to- $\frac{A}{2(c+1)} = q$, right? and this is the monopoly output and monopoly price what we do,

we substitute this in the inverse demand function and we get the monopoly price- $A -$

$\frac{A}{2(c+1)} = P$ and it is, so this is the monopoly price- $\frac{A(1+2c)}{2(c+1)} = P^*$. So diagrammatically this is

something.

Suppose, this is A, this is A, marginal revenue curve, demand curve, inverse demand curve it is this, marginal cost curve it is this, average cost curve, average cost curve is here it is this so it will be some nature like this. This output is A by 2 C plus 1, this and this monopoly price is this and the profit is this by plugging in this output. In this function, we get the profit, which is given by this rectangle. So, this is the second example when we have decreasing returns to scale.

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Now, we can do the same thing here by if we first determine the price and then the output. So here in this case, this is going to be the demand curve- $\pi = (A–P)$. So, we are now going to use demand function, not the inverse demand function and this it is going to be this one- $\pi = (A - p)p - c(A - p) - F$. So, when we have CRS case, that is the example one. So now we get this. This is the first order condition- $\frac{d\pi}{dp} = A - 2p + c$. Now, this is the monopoly price-

$\frac{A+c}{2} = p^*$ and you substitute here, you will get the monopoly output- $A - \frac{A+c}{2} = q$ and that is

and if you compare this and this you will see, they are same. So, the outcome is same.

Now, let us take the second example. So, profit is A minus P- $\pi = (A - P)P - c(A - P)^2 - F$. So, this is the output into price total revenue. Total variable cost, first order condition and this- $\frac{d\pi}{dP} = A - 2P + 2c(A - P) = 0 \implies A(1 + 2c) = 2P(c + 1)$. So, this is going to be the monopoly price, i.e $\frac{A(1+2c)}{2(c+1)} = P$ and the monopoly profit, monopoly output is going to be this much- $A - \frac{A(1+2c)}{2(c+1)} = q$ and from here, you will get this- $(A[2c + 2 - 1 - 2c])/2(c + 1) = q \implies A/2(c + 1) = q$ and if you compare this with the outcome in the second example, you will see that they are same. So, it does not matter whether you decide the output or you decide the price. You will get the same profit.
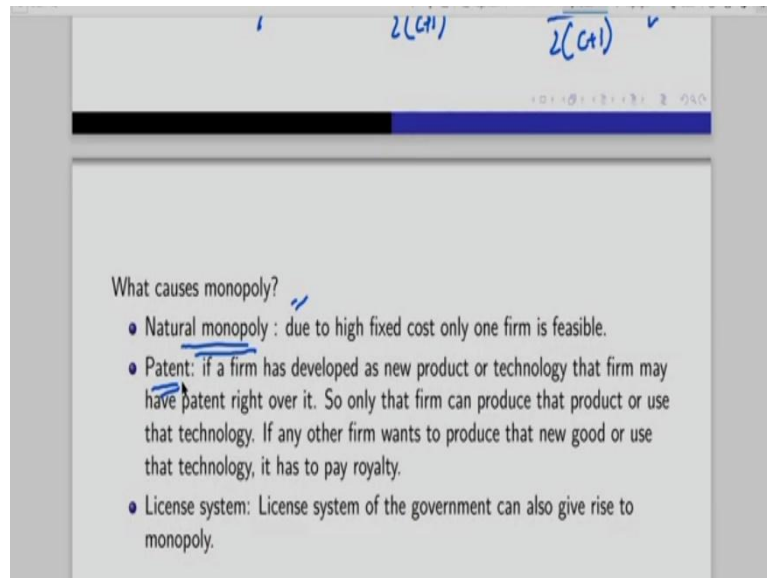
Now, the next question is, what causes monopoly? So, monopoly means that there is only 1 firm or 1 seller in a market. So, 1 may be the natural monopoly. If a industry has characteristics of that industry such that the fixed cost is so high that only 1 firm is feasible that if there is only 1 firm, then only it makes profitable. So natural monopoly, will always lead to a monopoly kind of thing. That is why we see in case of like electricity or that is the power supply or power transmission or like water treatment, all these are a form of a natural monopoly. Next is the patent right.

That is, if a firm develops a new product or a new technology and based on that if it when it develops a new product and suppose it wants to produce it and sell it, then it can have a patent over it. So only that firm now can produce that output. If any other firm produce that output, then that firm has to pay some royalty to this firm, which has developed this product or suppose a firm has developed a new technology. So, the firm while producing any output, it will have lot of advantage or it will produce a completely different product.

So, if it has a patent over it, then this firm can only, only this firm can produce this output and in that case what happens, all other firms, if they want to produce this output, or if they want to use this technology they will have to pay royalty to this firm. So, this firm has a monopoly power. Here it means that it has a lot of power to determine the price. Next is the license system in like prior to 1991 in India, we have a license system where the to set up a firm or to produce output, you require a license from the government.

So, in that case, sometimes happen that government only issue license only 1 firm. So that will automatically generate a monopoly or if suppose a firm is producing using some

hazardous substance. So, then government generally tend to give very few or 1 big firm is allowed to produce such things. So, in that case also there is a tendency to have a monopoly in the market, okay. So, these are some natural ways through which the monopoly is generated or come into existence in the market.

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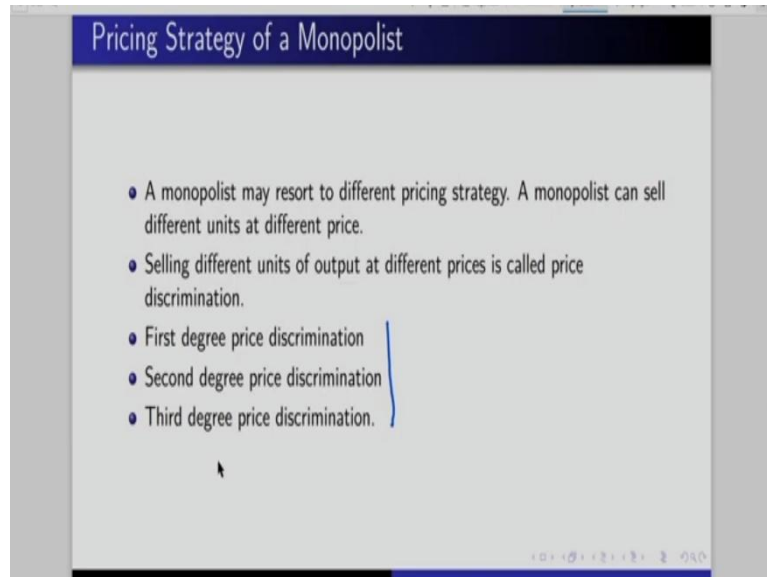
Next, we will study the pricing strategy of a monopolist. A monopoly can so we have seen before, how a monopoly save the market price and the optimal output its producing. Now, the next question is, is it the only way because the monopolist is the only 1 firm and if anyone wants to buy this product that person or that consumer has to buy from that firm only or that producer only. It has no other option. So, the monopolist can resort to different ways or you can use different strategy of pricing. So, one way is that you sell each item or each quantity at different prices.

So, this way of selling different prices or setting different prices for different quantities. This is called a price discrimination and the monopolies generally or they can do something called price discrimination. So, there are three forms of price discrimination. First, is the first-degree price discrimination. Second is the second-degree price discrimination and third is the third-degree price discrimination. So today we will only do the first-degree price discrimination.

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- In first degree price discrimination each quantity is sold to a consumer at the maximum price that the consumer is willing to pay.
- Each unit is sold at the maximum price a consumer is willing to pay. So there is no consumer surplus. So it is called perfect price discrimination.
- If two persons have different demand curve, each will be charged different price for the same quantity. Because the maximum amount the two consumers are willing to pay are different.
- This type of strategy is difficult to implement.

So, in first degree price discrimination, what happens, each quantity is sold to a consumer at the maximum price that the consumer is willing to pay, okay. So, what is the meaning of this?

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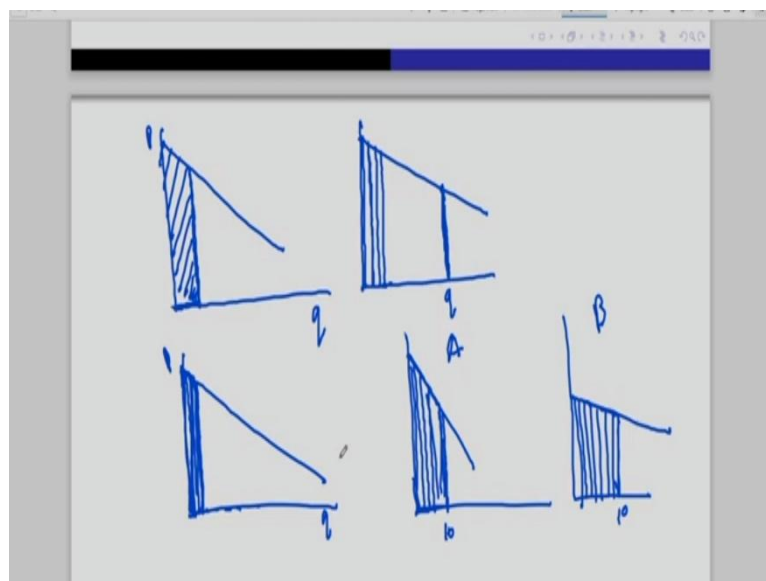
Meaning of this is this. Suppose, this is the demand curve of that person. So, if a consumer wants to buy this much amount of output, this whole amount so this amount. Then the maximum consumer is willing to pay is this whole amount, right? or for that, or if we take this amount and if consumer is willing to pay this amount for the first unit and suppose consumer is maximum consumer wants to buy this much. So, the maximum for the last unit consumer is willing to pay this much and we know why the demand curve is like this because as the price falls then only the demand increases. So, consumer has already bought this much these many units.

So, for this last unit, he is willing to pay less or you can understand it through marginal utility. So, the utility from each unit goes down. So, the maximum it wants to buy, wants to pay is only this much. So, what this monopolist can do, they can for each quantity. So, each dot the monopolist can charge what the maximum amount the consumer is willing to pay like this. So, in case, when suppose demand curve is like this and each dot here represents 1 unit or 1 quantity and for this each dot, we have a maximum that the consumer is willing to pay is given by this point in this demand curve, right?
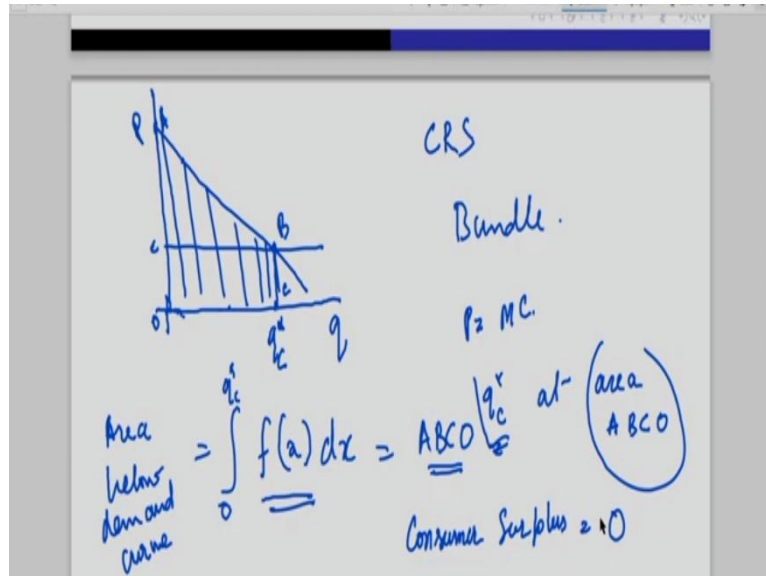
So, the monopolist can charge this price if he is buying this much quantity then the monopoly will charge this whole amount. So, for each unit, it will charge the different prices. So, this is called a perfect degree of price discrimination. You can perfectly discriminate for each quantity you are charging the different price to a individual.

So, an individual suppose the demand curves are different. Suppose, there are 2 individuals. One's demand curve is this A and person B's is demand curve is suppose this. Then for the first suppose, if this is the 10 unit. For the 10-unit, consumer A will be charged this whole unit. This whole portion because and it will be charged each quantity wise.

First unit, it will be charged this, for second unit it will be charged this, for second unit it will be charged this, second like this it will go on. So, this whole 10 units will cost this area consumer A and suppose this is 10 here and B also buys 10 unit. Then B will be charged this for each units. So, for 10 units, the B will end up being this whole reason. So, this is actually first degree price discrimination where you can discriminate across individuals that to each individual, you can charge different price and to each quantity, you can charge different price.

So, it is discrimination in both terms, consumer wise and also quantity wise, okay. Now for this if you want to do then use the simplest thing that suppose there are 3 individuals and suppose they buy different quantities, then you will have to, a monopolist will have to do lot of calculations, right? It will have to charge different prices to each individual and for each quantity. So, it is very difficult to implement this method. So, what in practice a monopoly can do.

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$$\text{Area below demand curve} = \int_0^{q_c^*} f(a)\,da = ABCO$$

CRS

Bundle.

$P = MC.$

q_c^r at $\binom{area}{ABCO}$

Consumer Surplus $= 0$

 Monopoly can resort to this kind of and monopolist here suppose this is the quantity and this is the price, okay and this is the demand curve, okay. Suppose the marginal cost is this so it is the case of CRS, right? Now here monopolist can practice something called it can bundle the good. Suppose this is for one consumer and in this situation, what we do, we make a very strong assumption that all the consumers are similar. So, this is the demand curve for each individual and so all the individuals have the similar demand curve. So, market demand curve is simply n times this, okay.

Now, for an individual if we consider the demand curve of one individual and this is suppose the marginal cost and this at this quantity, which we can call competitive because the price is equal to marginal cost because this is the price. Price is equal to marginal cost at this point. Suppose the monopolist produces this quantity, okay and this suppose this point is A, this point is B, this point is C and this point is O and monopoly says that you bundle it in such a way that you can buy q star c at the price given by the area ABCO.

So, you cannot buy any intermediate good or any other goods than this, other quantity than this. So, it is available only in one quantity that is Q star and the amount one has to pay, the buyer has to pay is this area ABCO, okay or you can say this whole region is this is q star c demand curve is and we integrate over this one. So, this whole region is the area below the demand curve, right? So, this is the area below the demand curve and which is equal to area of ABCO, okay. So, this is one way. So, suppose we are at n buyers.

So, n buyer each one will buy this much quantity by paying an amount of this amount and monopolist will charge this amount, right? when the cost function is CRS and the demand curve is of this nature, okay. So, this is one way. So here what is happening? So, consumer,

the monopolist is extracting all the consumer surplus, this whole. So, the consumer surplus is 0. The buyers do not earn any consumer surplus is equal to 0, okay. Everything is extracted by the seller or the monopolist.

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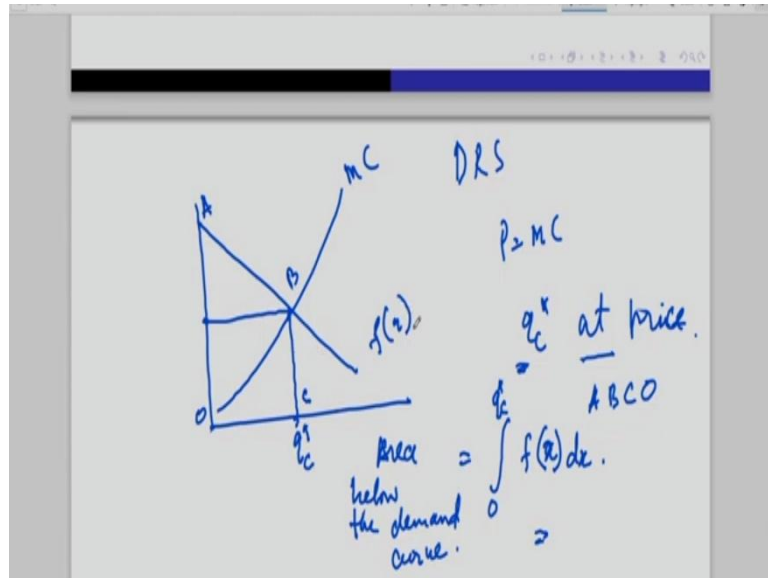
In case of decreasing returns to scale, we also get the same thing. This is the demand curve and the cost function is, marginal cost is this. So, this is q star c, why, because it is a competitive way because the price is equal to marginal cost at this output. So, this is the price. This price should be the competitive price.

But here monopolist will set this quantity at price for this quantity is this whole region, A B C and O. So, it is at price ABCO or the price is from 0 to q star c area under the demand curve, which is this. So, this area below the demand curve, so this is the case in case of decreasing returns to scale. So here the monopolist can charge that I can extract the whole surplus from the consumer, okay. Now this outcome has a very interesting property. If the monopolist can do first degree price discrimination, then you will see that it is a efficient outcome.

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- The outcome in first degree price discrimination market is Pareto optimal.
- The output produced in the case of first degree price discrimination is at the point where $p = MC$.
- The output level is same as perfectly competitive market.
- The total surplus which is sum of consumer surplus and producer surplus goes to the producer. It is same as the perfectly competitive market outcome.
- The consumer earns no surplus.
- This is also Pareto optimal because, if we want to make anyone better-off from this state some else has to made worse -off.

Why it is an efficient outcome? See or we can say efficiency in terms that it is a pareto optimal outcome, in the sense that consumer, we cannot make either the consumer or the monopolist better off without hurting someone else, or we can say the total surplus, sum of consumer plus producer surplus is maximum.

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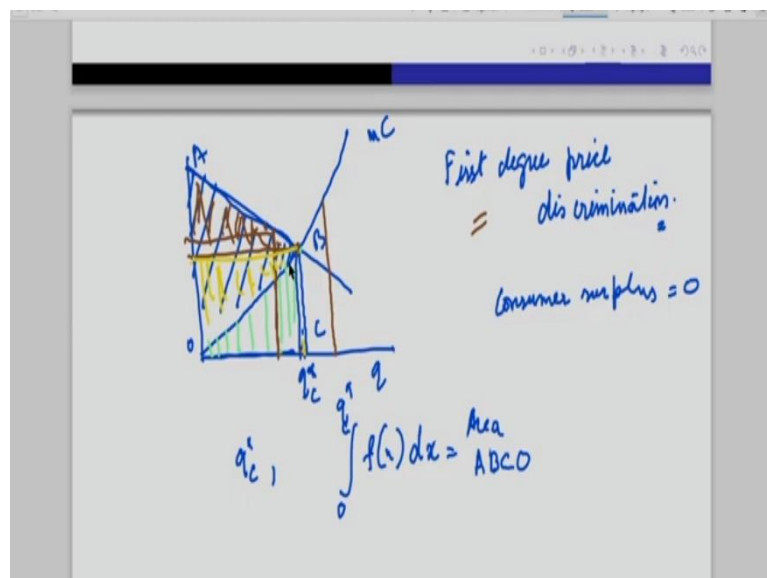
Here marginal cost is this and the demand curve is this. This is the output produce when there is first degree price discrimination, first degree, okay and the price charged so quantity sold to each individual is this and the price charged is, this whole area AB, right? This whole region. So, a consumer, the maximum a consumer is willing to pay for this much amount of output is this whole region. For each unit, it is willing to pay the point in the demand curve.

So, the whole region is a maximum for this much amount of output. So, the price is also that. So, price is A0 to q star c. This is the demand curve and we integrate over this demand curve- $\int_0^{q_c^*} f(x)dx$.

So, this whole region is giving me so the price is this or you can say area of ABCO, okay. So here consumer surplus is 0. So those who are buying they are not getting any surplus but what is the producer surplus? This whole region is the producer surplus from each buyer because if it is selling this much amount of output, the cost it is bearing is this for production of this. Fixed cost is already there. So, we are not bothered about the fixed cost. It will always be there. Now, or now, but this whole surplus because if it once produced this amount or this amount or this amount, it does not matter.

Fixed cost will be there right? So, but this whole amount is going to the monopolist. So, this whole surplus is received by the monopolist. Now, but the output produces this, right? where price is equal to marginal cost. Now, if you produce less output, suppose, okay, less output here. Then what is happening?

This much amount of surplus we are foregoing. It does not matter who is getting consumer or producer but this much sum of the surplus is from that sum of the surplus is being lost or we are forgoing that much amount. So, it is not better to produce amount of output less than this and if we produce more than this, then we are adding this much loss, okay. So this much negative amount.

So, it is going to be less than this total sample. So social welfare, which is sum of consumer plus the producer welfare is going to be maximum at this point. So, if the social welfare which is sum of consumer and producer, so that is maximum when we have the first-degree price discrimination.

But because the social welfare is silent about the distribution of surplus between the consumer and the producer but the distribution is very skewed, all the surplus is being extracted by the monopolist and the consumers are not getting any surplus but still the total surplus is maximum at this point, okay. So that is why social welfare is maximum.

So, this outcome is same as perfectly competitive outcome. Social welfare is being maximized and also this is a pareto optimal outcome. Why? Because if we now produce anything less here, then this surplus we are forgoing, right? and if we are producing more, then we are adding some loss and further what is happening? If we do a kind of

discrimination, like changes in the distribution. The distribution is such, 0 surplus to consumer and all the surplus to the producer. Then, what is happening? The producer is, if we fix any price here, then what is happening?

This much surplus is being received by the consumer and or if we take this A and fix this price, okay. So output is this and price. So now, what is happening? Consumer is getting this much surplus and the producer is getting this much surplus, right? but earlier the whole amount was received by the producer and 0 was received by the consumer. Now, what is happening here? We are making consumers better off at the cost of the producer. So that is why the initial distribution that is consumers are getting 0 surplus and the producers are getting all the whole surplus. It is a pareto optimal outcome.

So, even if the market price is fixed here, then the output going to be produced is this much and producer surplus is going to be this yellow region and the consumer surplus is this brown region, but what is happening compared to the first-degree price discrimination outcome here when the firm does the bundling.

Here, all the surplus is received by the producer and consumers were not receiving any surplus. So, there is a change in the distribution of the surplus but the total surplus is same. So, that is why the first-degree price discrimination is a pareto optimal because here, if we move to any other outcome where the total surplus is same, what you have to do? You have to change the distribution.

So, it means that if you want to make suppose the consumers better off, you will have to make the producers worse off at the cost of the producers. So that is why first-degree price discrimination is pareto optimal and it is also we have seen it is a social welfare maximising. So, this is actually from the chapter 25 of Hal Varian and the monopoly is from chapter 24 and in the next class we will do second degree price discrimination and the third-degree price discrimination. Thank you.