Petroleum Economics and Management
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Module - 02
Basics of Microeconomics
Lecture - 10
Elasticity

Hi everyone, I am Dr. Anwesha Aditya your instructor for the course Petroleum Economics and Management. So, we are in our module two where we are studying some concepts of Microeconomics.

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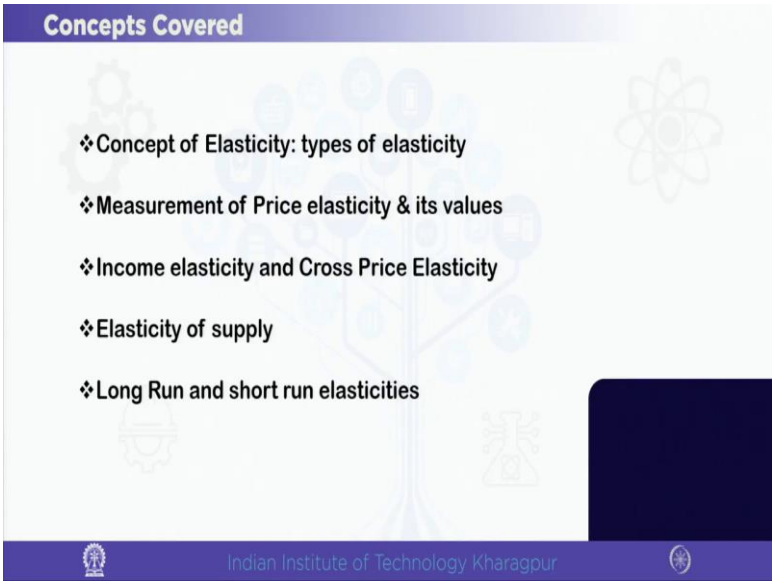

In today's lecture we are going to study a very important and relevant concept which is required for our purpose for studying the course petroleum economics and management; so, the concept is called elasticity. So, we are going to study what do we mean by elasticity; I think if you have gone through the lectures carefully so far you have already heard me saying or uttering this word elasticity many times; like, we have mentioned petroleum being inelastic ok. So, what does it mean; so, we are going to study it.

Now, again let me reiterate this is a very important concept and which will be used thoroughly in our course in many classes in many contexts. So, we should have very clear idea of what do we mean by elasticity. So, what is elasticity? Now, if you

remember we have already discussed about what are the factors on which demand depends, what are the factors on which supply depends; now, what happens if those factors change.

So, we have already seen that if the determinants of demand change what happens, if own price changes we move along a particular demand function. Now, by how much; that means what? That means, suppose we are consuming so many goods and services, suppose the price level changes ok. Suppose some hypothetical example of price of all the goods are doubled.

So, are we going to reduce the consumption of all the goods by the same amount, or suppose price is half. So, are we going to double the consumption of all the goods by the same amount. So, if price changes, quantitative demand will change, but may not be to the same extent for all the goods and services right; so, how do you measure that. So, that measurement is given by very important concepts of elasticity or let say if income increases.

So, are we going to increase the consumption of all the goods by the same extent? No; so, these measurements will be given by the concept of elasticity. So, in today's class we will start with defining elasticity, and what are the different types of elasticity which are relevant for our purpose. So, we will start with the elasticity of demand; now, there are three types of elasticities of demand; own price elasticity, cross price elasticity, and income elasticity.

So, one by one we will define them, but we will be spending more time on own price elasticity; we will define the own price elasticity, we will write down the formula of measuring own price elasticity, and we will discuss the values of own price elasticity. So, not only elasticity helps us to quantify the exact magnitude of change, but also it tells us about the nature of the good; which good is a necessary good, which good is a luxury good. So, we can tell by looking at the value of elasticity, the type of the good.

Now, after studying the different types of elasticity, we will also study the elasticity of supply. So, how do you measure elasticity of supply; the formula of elasticity of supply and then finally, we will see how the elasticity values vary over time because elasticity is something which is dependent on time. So, over time how elasticity values vary ok; so, this is how we have organized today's lecture.

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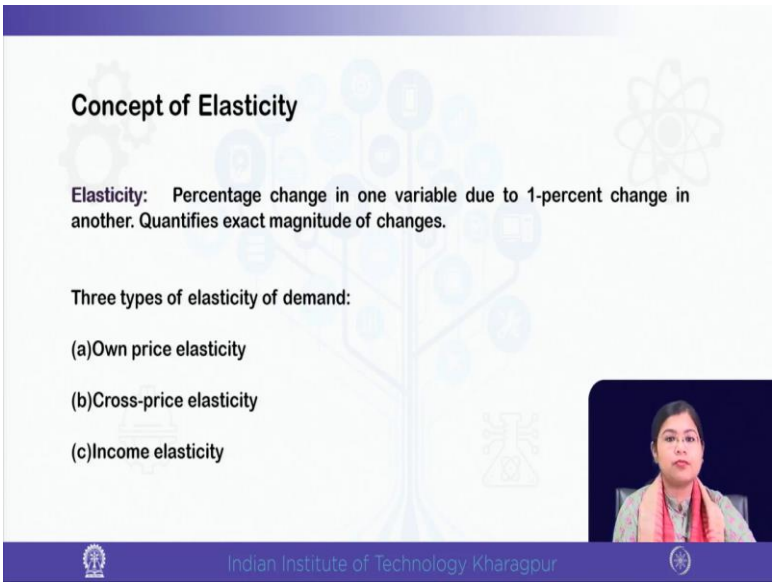

So, first let us start with defining elasticity. So, what do we mean by elasticity? Elasticity is defined as the percentage change in one variable due to one percent change in another variable; therefore, it quantifies the exact magnitude of change ok.

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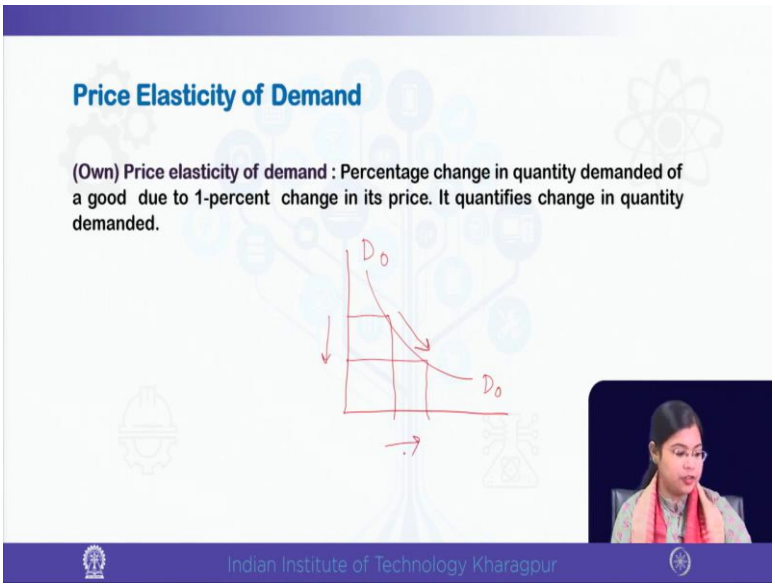

Now, as I mentioned there are three types of elasticity; so, let us first start with the own price elasticity of demand what is that? So, just now I was taking the example that if price changes, how much quantity demanded will change. So, if price changes by one

percent, how much quantity demanded will change this will be given by the formula of own price elasticity.

So, we can define the own price elasticity of demand as the percentage change in quantity demanded of a good due to one percent change in its own price, other things remaining unchanged. That means, other things remaining unchanged, if price changes how much quantity demanded will change. So, graphically we know that if other things remain unchanged and if price changes then we move along a particular demand curve ok.

So, there is a no shift in the demand curve we move along a particular demand curve from one point to another. So basically, own price elasticity graphically helps us to quantify this movement along the demand curve along a particular demand curve ok; how much, if price falls how much quantity demanded will change.

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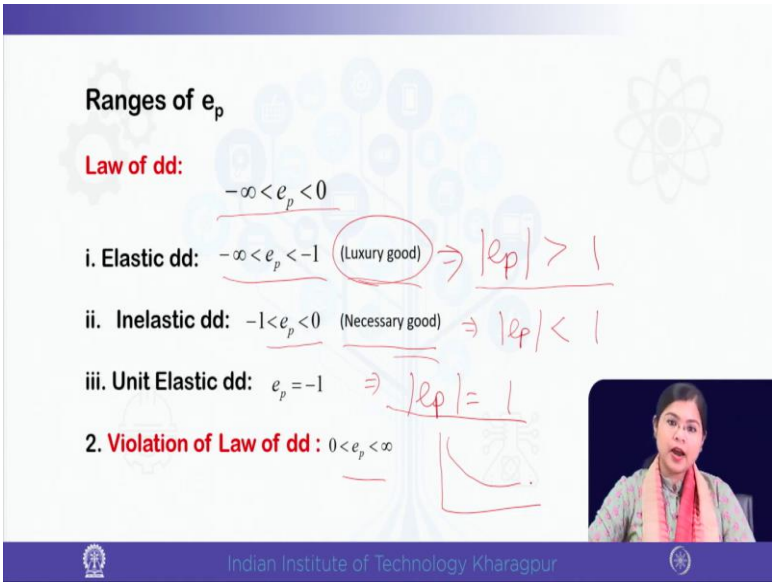

So, what are the values of elasticity ok, I will also give you the show you the formula of elasticity. Before that, what are the values of elasticity? We need to know, as I just now mentioned at the beginning of today's lecture that elasticity not only gives us the exact magnitude of change, but it also helps us to classify the goods into different categories.

So, how do we use elasticity for classifying good? Using the values of elasticity. So, elasticity is percentage change in quantity demanded due to one percent change in price.

So, if price increases by law of demand we know quantity demanded falls; so that means, as long as elasticity is negative, what can we infer? We can say that the law of demand holds for that particular good.

So, if price increases quantity demanded falls; so that means, elasticity value is negative, you see the first range is elasticity being less than 0; so, minus infinity to less than 0 ok; so, law of demand holds right. That means, if we see that the elasticity value is positive; so, law of demand is violated. So, the second broad range is where the law of demand is violated.

So, we already discussed about some examples some like the Giffen good or goods with snob appeal. So, these are some examples of violation of law of demand, but these are very rare and their empirical validity is debatable. They are mainly of theoretical phenomena; like, the Giffen good the existence of Giffen good in reality is subject to lot of debates it is a controversial topic.

So, mainly we see empirically that law of demand holds; so, we will be concentrating on this first broad range of elasticity where elasticity is negative, yeah. So, now under this broad range of law of demand we now need to categorize the goods by looking at the value of elasticity. The first range is when we have elastic demand; that means what? That means, you see the value of elasticity here is less than minus 1.

So, minus infinity to minus 1, what does it mean? That means that, if there is 1 percent change in price, quantity demanded will change by more than 1 percent. So, there is a more than proportionate change; that means, in absolute value what will be the sign of elasticity? It is greater than 1.

Suppose price falls by 2 percent ok, then we can say that quantity demanded increases by more than that ok. Because for all the goods if price falls quantity demanded will not increase by the same percentage. We need to know that suppose price of all the goods are falling say hypothetical example in our consumption basket in daily life we consume lot of goods and services.

So, if price falls, are we going to increase the consumption of medicine? No, because we will be taking the medicine up to the level which is prescribed by the doctor right. So, if price falls, we are not going to double our consumption of medicine. So, how to know

that? But if price falls we may buy, suppose discount is going on we can buy some electronic gadgets like mobile phone or laptop or we can buy accessories, dress materials; so, these are called luxury goods.

So, elastic demand means; if price changes, quantity demanded response more than proportionately; if price falls, quantity demanded increases more than proportionate to that fall; if price increases, quantity demanded falls by more than proportionately. So, the negative relationship is there, but the proportionate change percentage change is greater ok. So, this is the range where e_p in absolute value is greater than 1; so, this is called the elastic demand the examples include the luxury good.

Now, what is the next case? Next case is when the elasticity value is negative, but it is lying between 1 to 0; so, minus 1 to 0 to be more specific. That means, what will be the elasticity value in absolute term? It is less than 1. So, law of demand is holding, but what is happening now; if price changes, quantity demanded also changes, but by less than proportionately; so, this is the case of inelastic demand.

So, we are taking the example of medicine; now suppose, price increases. Now, if price increases and if someone has to take a medicine daily on a daily basis; suppose for example, insulin for diabetic patient. So, even if price increases if the diabetic patient is dependent on insulin that patient has to buy the medicine right. So, even if price increases, quantity demanded may be falling to some extent, but will be less than proportionate.

So, if suppose the doctor has also given some supplement, some nutritional drinks those can be cut back, but the prescribed amount of medicine must be taken by the patient. Therefore, even if price increases, quantity demanded may fall, but by less than proportionately; so, examples include medicine.

So, just now I told medicine; so, that is the example of necessary good. Even you see for our purpose this is very important, because petroleum also comes under this category of inelastic demand. Because, we already studied the indispensable nature of petroleum products, we have studied that we do not have easy substitute for petrol.

So, what happens even a price of petroleum increases, can we suppose one person has a petrol driven car; can the person change the car overnight? No. Therefore, even if price

increases, quantity demanded of petrol may fall slightly, but to a lesser extent. The person may be cutting back cutting down the number of trips, may be using public transport, but cannot change the car; so, has to refill petrol in the petrol driven car right.

So, if price increases, quantity demanded falls, but by lesser magnitude. So, this is the case of inelastic demand and the examples include necessary products like medicine or food products or petroleum products. So, the products which have less substitute at least in the short run; so, we are dependent on that even if price increases, quantity demanded may fall; but by less than magnitude then the price increase.

So, these classifications are very important; and third is a case where there is exact percentage change. So, if price increases by say 2 percent, quantity demanded falls by the same 2 percent; if price increases price increases by 1 percent, quantity demanded falls by 1 percent. So, the negative relationship between price and quantity demanded is there, but the percentage changes are just same; so, this is the case of unitary elastic demand.

So, e_p is equal to 1 in absolute value; so, e_p stands for the own price elasticity. We also use the notation epsilon to denote elasticity; so, e_p epsilon all stand for elasticity ok. So, the example of unitary elastic demand is suppose the demand function is of rectangular hyperbola; so, elasticity is 1 ok. So, this is how we can classify the goods by looking at the elasticity value; so, this is very important for our purpose.in

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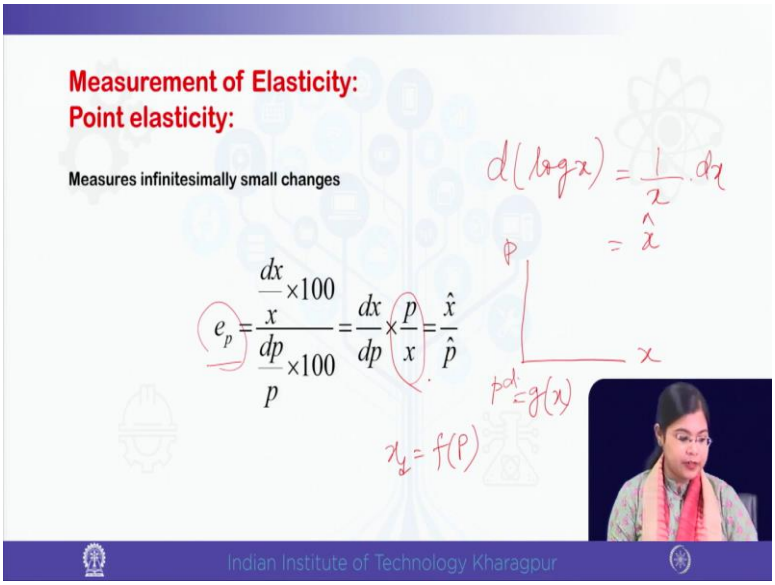

Now, how do we quantify, how do we measure elasticity, what is the formula of elasticity or the own price elasticity. So, often in economics we are concerned about what is happening for very small change ok. So, the widely used formula of elasticity is the point elasticity; there are other formula, but due to time constraint we are just covering that part of microeconomics which is required for successful completion of the course petroleum economics and management.

So, we will be just considering the own price elasticity formula is given by the point elasticity ok. So, how do you measure elasticity for very small change in price? So, point elasticity measures infinitesimally small change. So, the definition you already know is the percentage change in quantity demanded divided by percentage change in price.

So, suppose we are using the notation x to denote quantity demanded and p stands for price of course. Therefore, the what is the numerator? Numerator is percentage change in quantity demanded; dx by x into 100 divided by the denominator is percentage change in price dp by p into 100. So, see 100 is cancelled out from both numerator and denominator then, we can write this as dx by dp into p by x.

Now, we can simplify this and we can write in terms of dx by x can be written as x hat and dp by p can be written as p hat, what is this hat? Hat means, it is just suppose we take a logarithm of a function and if we totally differentiate. For example, suppose if we take a log of a function, we can write it as d of log x.

So, if we totally differentiate this function what do we get? d of log x this is 1 upon x into dx. So, this dx by x we are actually writing in terms of x hat, this you can also write it as dx by x divided by dp by p. Just for simplicity we are writing and often for calculating also, if we can simplify the functional form by taking a log it saves our time it makes the solution easy; so, we can do that ok.

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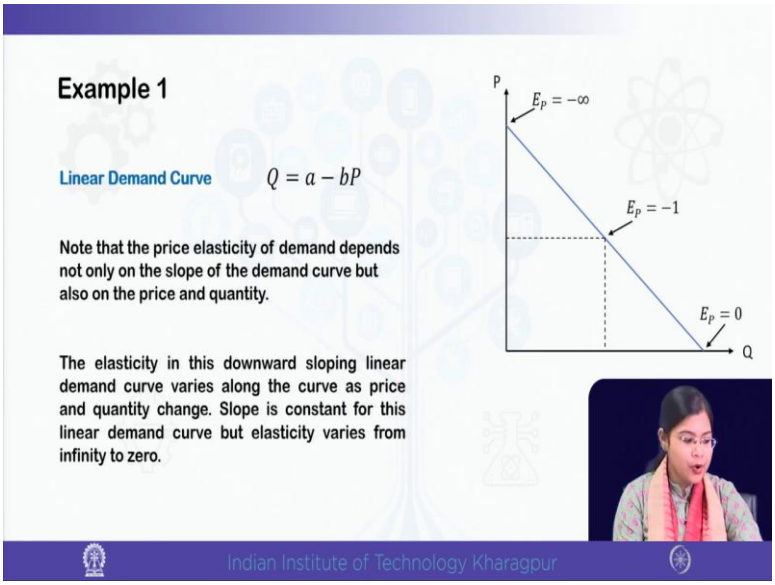

Now, you see the relationship between slope and elasticity. Now, one misconception is that slope and elasticities are negatively related always; means, inversely related. But that may not be true because you can see from this elasticity formula e_p is equal to dx by dp into p by x ok.

Now, dx by dp is what? That is the slope of the direct demand function, because if you remember that direct demand function is x d is equal to f of P. But, the way we are plotting we know that we are working with the inverse demand function; that means, we are basically drawing the inverse form where inverse demand function is pd is equal to g x, where g is equal to f inverse.

So, provided inverse exists we work with the inverse form of the demand function; so, in the slope of the inverse demand function is dp by dx. Now, you see we can see that in the elasticity formula you have e_p is equal to this 1 upon the slope of the inverse demand function into p by x. So, we have this p by x term also, we cannot ignore this p by x term; so, we cannot say that elasticity and slope are always inversely related.

So, we can see the examples along a downward sloping linear demand function, you can calculate and you can see that the elasticity value varies from minus infinity to 0. And at the midpoint it is equal to minus 1 at the vertical intercept it is equal to minus infinity, at the horizontal intercept it is equal to 0 ok.

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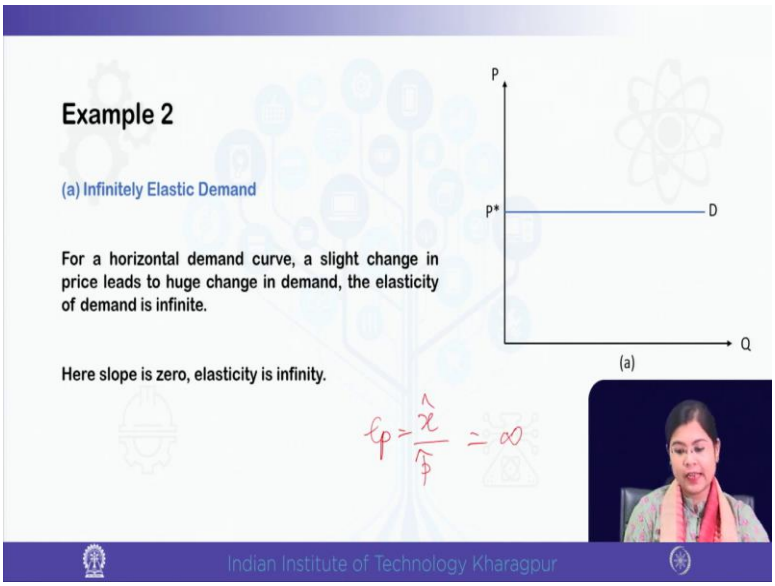

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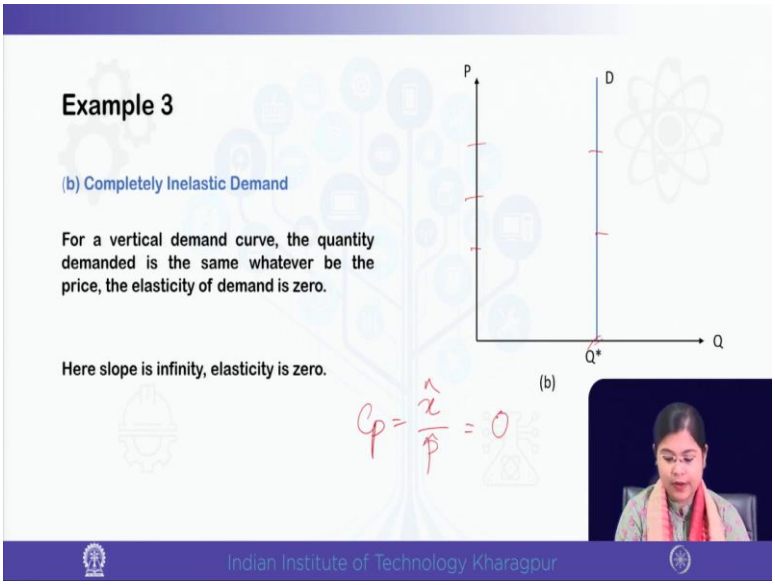

Only there are two cases where the demand function is either a horizontal line. So, here we can see that elasticity here is infinity and slope is 0 and the other case is when we have a vertical straight line demand function. Therefore, the slope is infinity, but elasticity is zero, because here you see quantity is fixed; so, does not matter if any price changes quantity is fixed.

So, elasticity formula e_p is equal to x hat by p hat; so, if the x hat or Q hat is fixed it is not changing; therefore, elasticity e P will be equal to 0; so, elasticity is x hat by P hat.

So, here you can see that x hat is equal to 0; so, which makes the elasticity equals to 0. In this previous example, e_p is equal to x hat by p hat, I am just writing in the absolute value terms. So, x here P is equal to p hat is 0, because P is fixed ok; therefore, the denominator is 0; therefore, see elasticity will be infinity ok.

Only in these two cases slope and elasticities are negatively inversely related completely, otherwise there is no such relation. Because, here we can see along a linear downward sloping demand curve the slope is varying from minus infinity to 0 ok. For a particular demand curve, the elasticity is varying from minus infinity to 0; whereas, the slope is same.

Similarly, for a unitary elastic demand I just took the example of rectangular hyperbola demand function and I just mentioned that the elasticity is equal to 1 everywhere. So, for a rectangular hyperbola demand function the elasticity is 1 everywhere, but the slope is varying. So, we can see that for a rectangular hyperbola demand function, the slope is varying elasticity is unchanged.

For linear downward sloping demand function; the slope is same, but elasticity is varying from minus infinity to 0. Therefore, we cannot conclude that slope and elasticities are always inversely related, apart from these two cases only this example 2 and 3 where the demand function is either flat horizontal line or vertical straight line ok.

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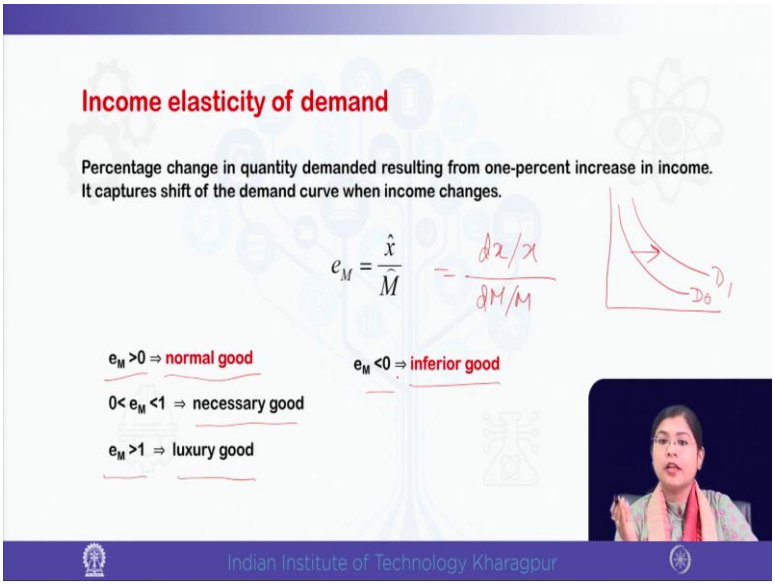

Now, we come to the another concept of elasticity, suppose our income increases. If our income increases, are we going to increase the consumption of all the goods and services by the same extent. If our income increases are we going to increase the consumption of medicine? No, we may be buying more electronic products, more accessories right.

So, if our income changes, consumption of all the goods and services are not changing by the same extent. So, graphically we have already studied that if income changes demand curve will shift the entire demand curve shift. Suppose, there is income increase; so, for most of the product the entire demand curve will shift.

Now, by how much, because for all the products the demand curve shift may not be to the same extent; so, income elasticity helps us to quantify this magnitude of shift in demand. So, how do you define income elasticity? This is the percentage change in quantity demanded due to one percent change in income other things remaining unchanged.

So, the notation for own price income elasticity is e_M is equal to x hat by m hat; that means, e_M is equal to dx by x. This is the percentage change in quantity demanded, I am not writing the 100, because 100 again will be cancelled out divided by dM by M. So, this we are writing in terms of hat; so, e_M is equal to x hat by M hat or you can also use the notation in terms of epsilon, epsilon m.

So, as I was telling that for most of the good if income increases quantity demanded increases; so, e_M will be positive; so, for those goods are called normal good ok. If income increases quantity demanded increases, but may not be to the same extent right. So, now within this classification of normal good, we can now see the sub ranges.

If suppose income increases, quantity demanded increases, but by less than proportionately ok. So, income increases by 10 percent quantity demanded increases, but by say less than 10 percent. So, we have e_M positive, but less than 1; so, these are the examples of necessary good like medicine or food products.

The second case is where if income increases, but quantity demanded increases by more than proportionately. So, if we reverse the argument; if income falls, quantity demanded falls more than proportionately for the luxury goods; like dress material, accessories, electronic products. But if income falls; you have to take some medicine, you have to

buy food items; so, for those necessary products quantity demanded may fall, but by less than proportionately.

So, e_M is greater than 1 for luxury good and e_M is less than 1, but positive for necessary goods; and there are some exceptions for which if income increases, quantity demanded may fall; so, these are called inferior good. So, income elasticity is negative for the inferior goods; examples include like, we have discussed Giffen goods like very poor quality food grain.

So, if income increases, then the household may be going for better quality food products like dairy products, so fruits vegetables; then, the household can reduce the consumption of poor quality grains ok. So, the income elasticity concept is also very important, it quantifies the shift of the demand curve due to the change in income.

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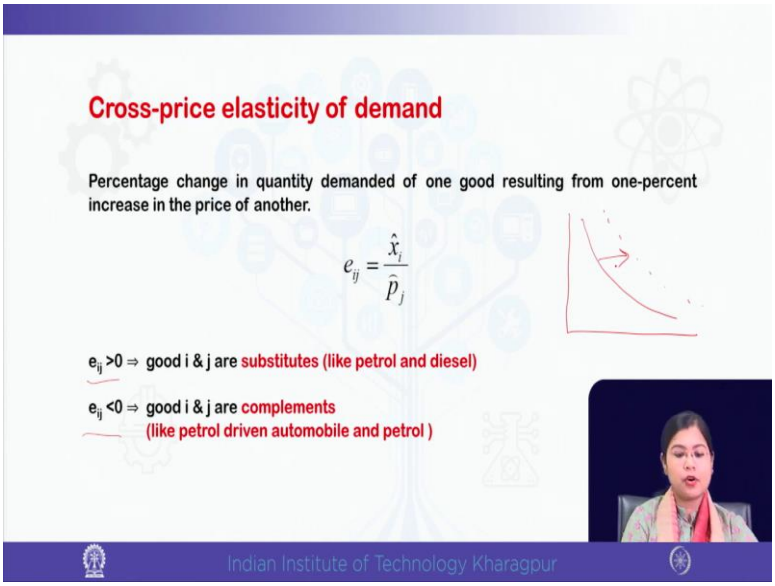

Next concept of elasticity is cross price elasticity of demand, because we know that quantity demanded of a good also depends on price of related good. Therefore, what will happen to quantity demanded of a particular good; say good i, if price of good j changes. Suppose, we consider that a good i is petrol ok. Now, if price of goods j suppose diesel changes; so, what will happen to the quantity demanded of petrol.

So, that is given by the formula of cross price elasticity of demand. So, it is the percentage change in quantity demanded of one good resulting from one percent change

in the price of another good. So, in this example I was talking about the demand for petrol depends on the price of diesel. So, what will be the sign of this cross price elasticity of demand? So, e_{ij} is equal to mathematically the formulas is percentage change in quantity demanded of ith good due to percentage change in price of jth good; so, xi hat divided by pj hat ok.

So, if price of diesel suppose, here diesel is suppose the jth good price of diesel increases; so, what will happen, demand for diesel will fall; therefore, demand for petrol will increase. So, how pj and xi are related? So, we are starting with, suppose pj increases; so, demand for good j will fall, xj will fall, but demand for good i will increase because they are substitutes petrol and diesel. Therefore, we can see that e_{ij} the sign of cross price elasticity will be positive, good i and j are substitute.

Now, what is the other example, suppose we consider that good i is now petrol driven car and j is suppose petrol ok. So, if petrol price increases, demand for petrol driven car will fall; so, e ij will be negative, if the goods are complements ok. So, this is how we use the concept of cross price elasticity of demand. Therefore, again if price of related good changes how the demand curve will shift graphically; so, this quantification is given by the concept of cross price elasticity of demand.

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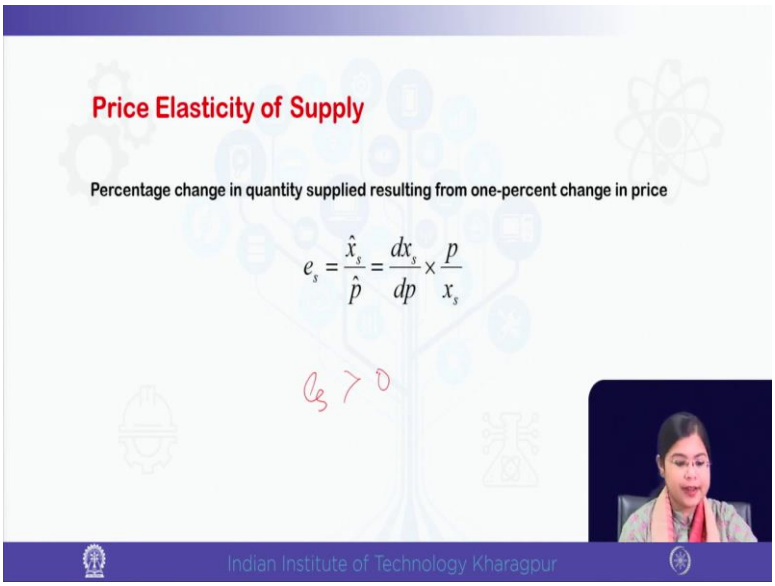

Now, the next concept of elasticity is the price elasticity of supply. So, what is that? Now, what happens to the quantity supply if own price of a good changes; so, this is

given by the price elasticity of supply, because quantity supply is a function of its own price. So, if price changes how much supply you will change, suppose the world oil price is changing; so, how the OPEC and non-OPEC suppliers will change the oil price?

So, the notation for elasticity of supply is given by e_S or you can also use eta S; so, e_S is equal to x S hat by p hat. Now, you can see that as long as law of supply holds, e_S will be positive right. So, for most of the product law of supply holds; so, e_S will be positive. However, if the law of supply is violated e_S may be negative, but those are only rare cases.

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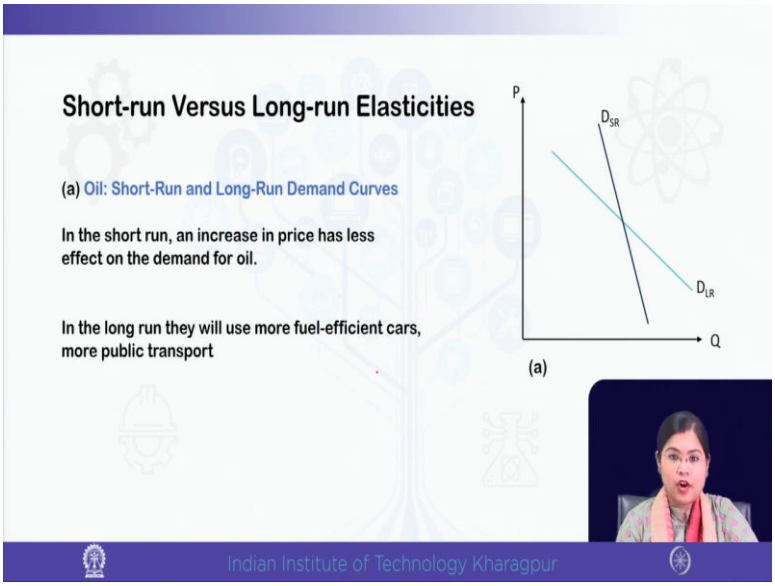

Now, one very important factor while discussing about elasticity is that, elasticity value can vary over time ok. Like I was taking the example of increase in price of petrol; so, if someone has a petrol driven car that person will not be able to switch the car or change the car overnight. What the person can do? The person can reduce the number of trips, the person can use the car only for very necessary trips and maybe using more of public transport right.

So, if any price of petrol increases suddenly, quantity demanded may fall, but by a lesser extent. But over time if the increased price trend continues; so, what will happen? The person can sell off the car or can change the car to some other say motorbike or say electronic vehicle right. Therefore, what we can see is that, over time we can change our

consumption pattern gradually. For therefore, if there is a same increase in price quantity demanded will now fall by a greater extent over time.

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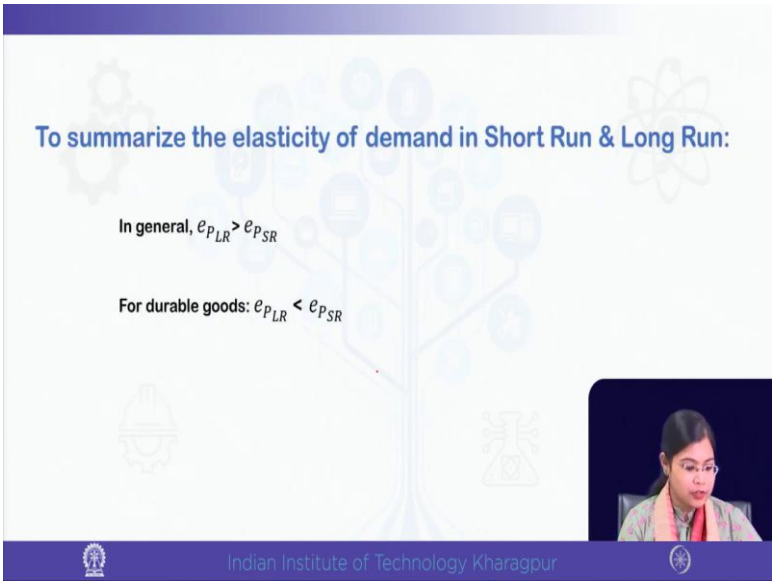

Therefore, we can conclude that elasticity in the long run will be greater compared to elasticity in the short run. Because, in long run we have more substitutes available like the electronic vehicles and also we can change our consumption pattern more over time ok.

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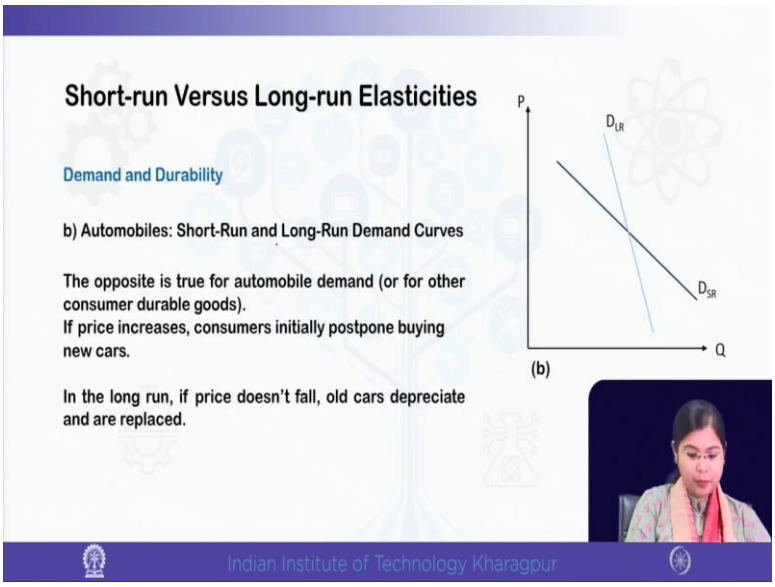

But there is one exception, oh you can refer to the book of Pindyck and Rubinfeld and you can study in detail with the book mentions that for consumer durables. Like say, car or AC; we see the opposite trend, the elasticity values are greater in the short run than in the long run, why? Suppose you thought of buying a car, but price of car is increasing; so, the consumer can postpone the purchase.

But, if the price increase continues next to next year or after sometime also, if the price is increased and it is being increased continuously. Then, the consumers if they need the car they have to buy the car; suppose, the summer is coming if the household has thought of purchasing one AC ok. So, seeing the rising price trend the consumer can postpone the purchase ok.

But, if the increase in price trend continues and given the summer the household may be forced to buy the AC in the next year right. Therefore, if price increases, quantity demanded falls sharply in the short run; therefore, demand is more elastic in the short run. In the long run even if price is greater, the consumers are forced to buy; therefore, elasticity will be less in the short run.

So, overall we can see that for durable goods the consumer durables, elasticity will be greater in the short run than in the long run, but this is an exception. Overall we can conclude that elasticity values are higher in the long run than in the short run.

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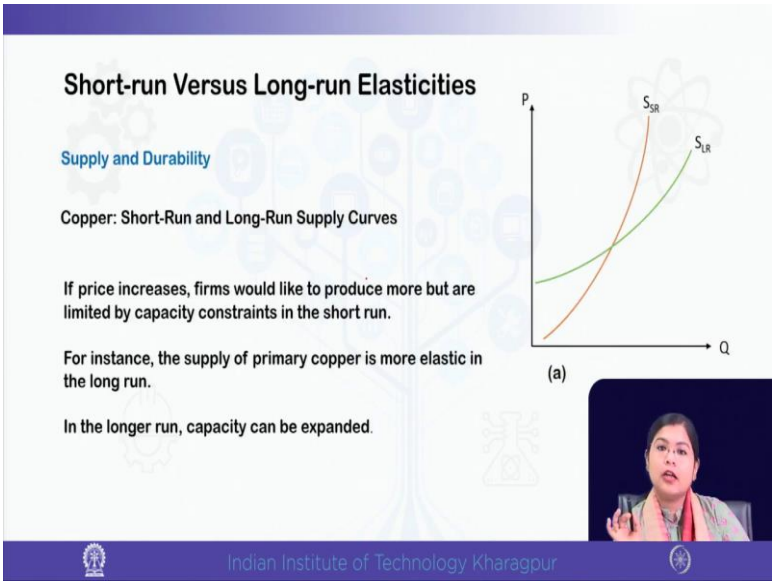

Same nature for supply side also; so, for supply side also we can see that elasticity values are greater in the long run than in the short run, why? Because we know that production requires resources land, labour, capital, entrepreneur. And the economies are constrained by resources; same the firms are also constrained by resources; so, even if say demand increases. Suppose for example, demand for agriculture product suddenly increases, but agriculture production depends on the season.

So, if this production season is over, the farmers may not be able to supply more if there is no inventory stock ok, because the farmer has to wait for the next production season. Therefore, over time if price increases is in the next season, the farmers will produce more. Therefore, elasticity value will increase in the long run than in the short run; same thing you see in the manufacturing also, the firms need machinery, factory space those may be limited in the short run.

So, as long as the production capacity is constrained in the short run; so, the if the rising price trend continues the firm can expand its capacity, but that will be possible in the long run. Because, the firm may be using some machinery which is the firm needs to import, the firm has to expand the factory space, the firm needs more engineers more workers. Therefore, elasticity values will be higher in the long run than in the short run.

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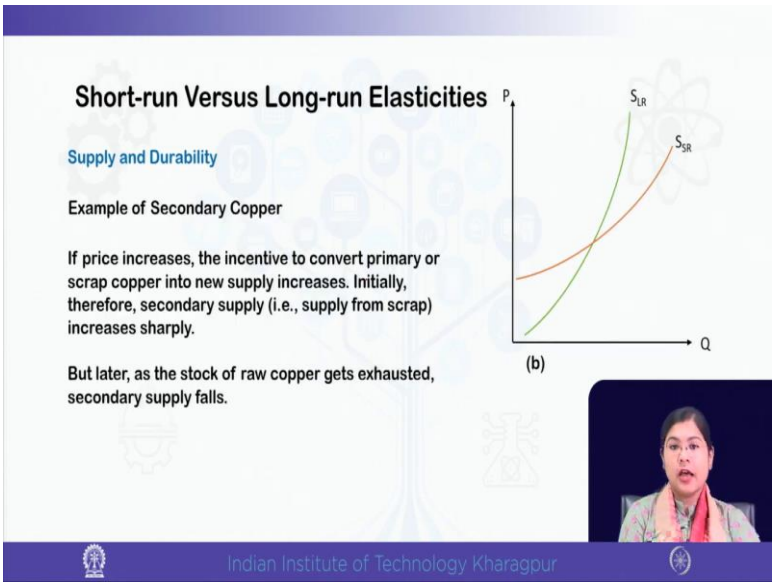

However one exception is there which is the case of say some secondary supply; that means, where you do not have any capacity constraints in the short run, but this is a very

typical example. So, the example suppose consider we convert some metal or mineral say copper from raw to the final version. So, the firm starts the production of converting the raw copper to the secondary supply; so, the rock copper is already there.

So, if price increases, the rate of conversion increases right. Now, with this rising price trend what will happen at some point of time, the firm will exhaust its supply or stock of raw copper and at some point of time the supply of raw copper is fixed. Therefore, if price increases in the short run; the rate of conversion will increase, but the firm will be subject to the capacity constraint in the long run.

Therefore the cases where the firm does not have any capacity constraint which is once again a very rare case the elasticity will be higher in the short run. But, this is just an exception overall we can say that elasticity of supply will be greater in the long run than in the short run ok.

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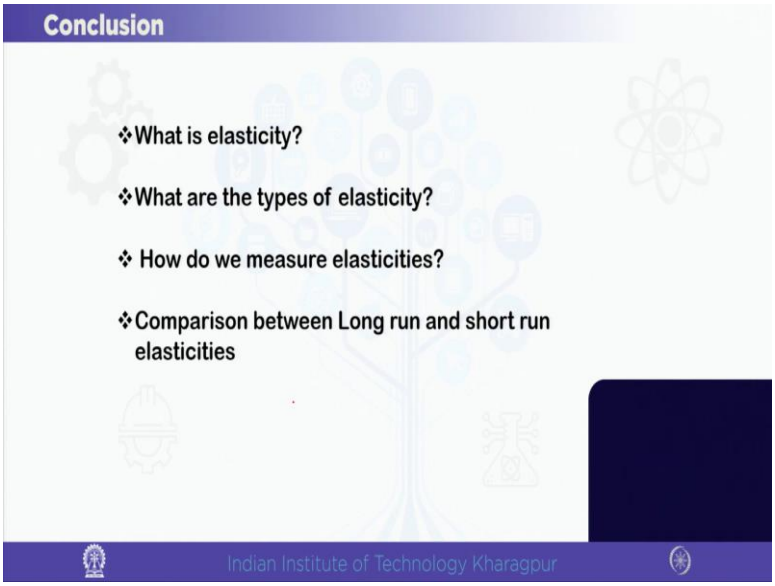

So, if we summarize today's class we discussed very important concept of elasticity, price elasticity, income elasticity, cross price elasticity and elasticity of supply. We discussed their formula, their definition, and their values and then we classified the products according to the value of elasticity. And finally, we compare the elasticity values over time, how elasticity values vary over time.

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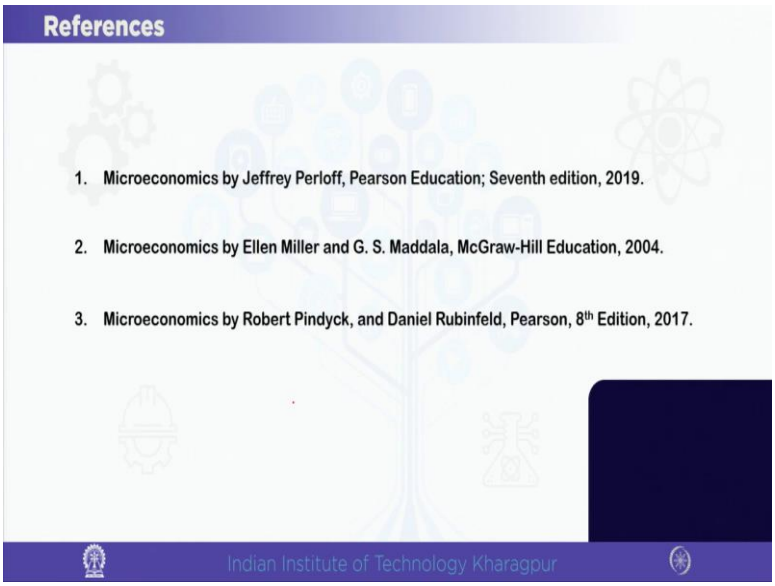

So, any standard microeconomics book will be helpful for studying this part. But, this is a very important lecture for a successful completion of the course petroleum economics and management so.

Thank you very much.