Managerial Economics
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Lecture - 3
Introduction to Managerial Economics (Contd…)

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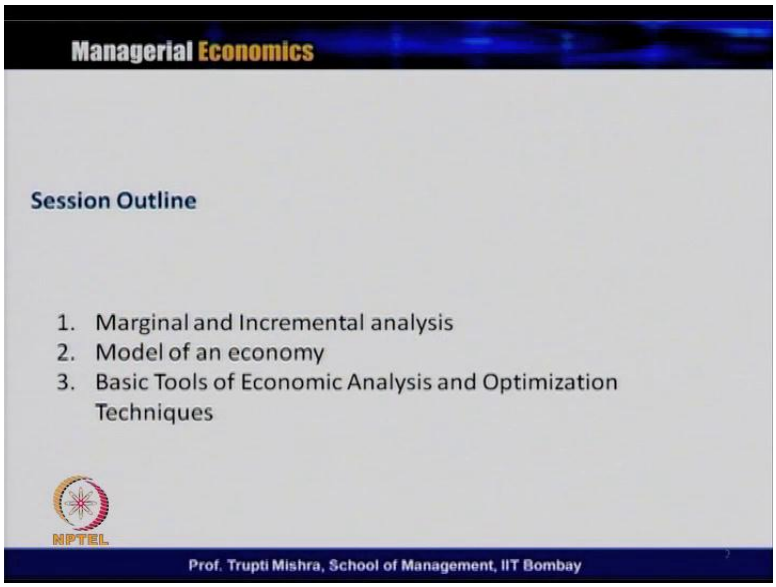

So, welcome to the third session of managerial economics. We are in the first module of managerial economics, which deals with the introduction and fundamentals to the managerial economics.

So, if you remember in the last class, we just started our discussion about the marginal analysis. So, in today's class, we will talk about the marginal and incremental analysis first, then we will talk about a model of any typical economy, how it works, what are the different sectors, how the flows works between two different sectors. And then we will focus on the basic tools of economic analysis and optimization techniques.

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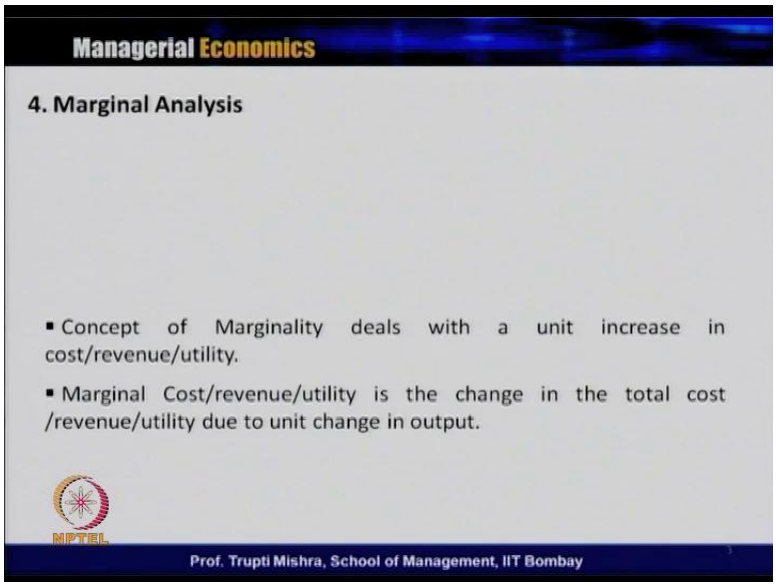

So, coming to the marginal analysis, as we discussed in the last class, marginal is always a unit change in any of this variable, whether the variable is cost, whether the variable is revenue, whether the variable is utility. Whenever there is a change in the output, what is the corresponding change in the cost, what is the corresponding change in the revenue or what is the corresponding change in the utility. That is the marginal cost, marginal revenue and marginal utility.

So, marginal cost is the change in the total cost, because there is a change in the output. Marginal revenue is the change in the total revenue because there is a change in the output. Output leads to revenue. Marginal utility is the change in the utility because the consumer consumes one more unit of the output or one more unit of the product.

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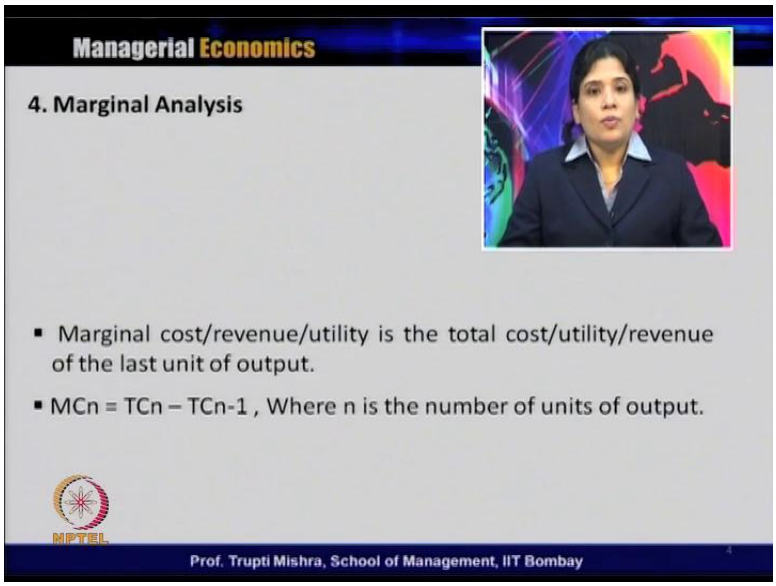

So, marginal cost or marginal revenue or marginal utility is the total cost utility revenue of the last unit of output. Whatever is the total cost or whatever is the total utility or whatever is the total revenue of the last unit of output, that is the marginal cost, or marginal revenue or marginal utility of the corresponding unit.

So, if you need to identify what is the marginal cost of n unit, then it is the total cost of n unit minus total cost of n minus 1 unit, where n is the number of units of output. So, this marginal cost of n unit is nothing but the total cost whatever comes in the last unit of the output.

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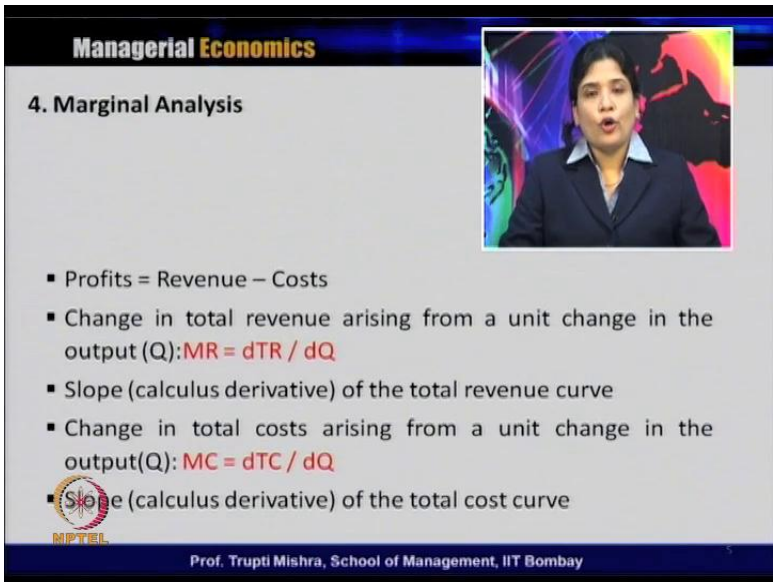

So, we know that profit is the difference between the revenue and the cost. Whenever there is a change in the total revenue due to unit change in the output, we get that as the marginal revenue. So mathematically, we can find this by taking the first order derivative of total revenue function with respect to Q, that is output and geometrically this is the slope of the total revenue curve.

Similarly, change in the total cost arising from the unit change in the output gives us the marginal cost. Mathematically, we find marginal cost by change in the total cost with respect to change in the Q or that is output. So similarly, geometrically the slope of the total cost curves gives us the marginal cost curve.

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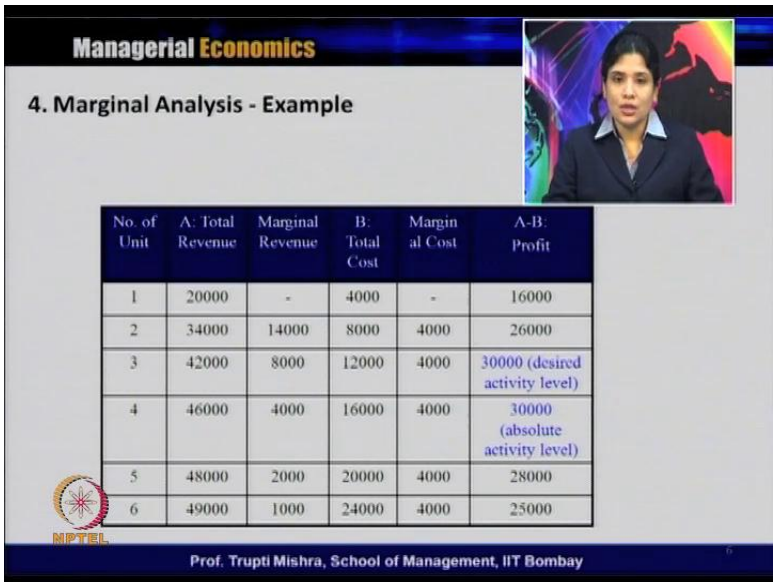

No. of Unit	A: Total Revenue	Marginal Revenue	B: Total Cost	Marginal Cost	A-B: Profit
1	20000	-	4000	-	16000
2	34000	14000	8000	4000	26000
3	42000	8000	12000	4000	30000 (desired activity level)
4	46000	4000	16000	4000	30000 (absolute activity level)
5	48000	2000	20000	4000	28000
6	49000	1000	24000	4000	25000

We will take an example to understand all these concept, particularly with respect to marginal analysis. So, if you look at in the table, this is a hypothetical table. So, this information is not relevant to the real world. So, there are 6 units of output that is 1 2 3 4 5 6. The second column gives us the total revenue, the third column gives us the marginal revenue, the fourth column gives us the total cost, the fifth column gives us the marginal cost and the last column gives us the profit.

As we know, total profit is equal to total revenue minus total cost. So, if you look at it, when there is 1 unit of output, the total revenue is 20000 and total cost is 4000. So, the profit comes to 16000. Since there is only 1 unit, there is no marginal revenue associated with this unit of output.

When there are 2 units of output, the total revenue is 34000 and marginal revenue is 14000. Now, how this marginal revenue comes? This marginal revenue is the difference between the second unit and the first unit. Similarly, what is the total cost? Total cost is 8000. Here, the cost is fixed because for 1 unit, if it is 4000 and for the second unit it is 2 units, and hence it is 8000 and then the cost remains constant. So, if you look at it, we will get a constant marginal cost because the per unit cost remains constant.

So, in this case, total cost is 8000 for 2 units and marginal cost is 4000. Now, how we get this marginal cost as 4000? That is the difference between the cost associated with the second unit of output and cost associated with the first unit of output. So, this is 8000

minus 4000. So, marginal cost comes to 4000. In this case, how we will find out the profit? The profit is, total revenue is 34000 and total cost is 8000. So, 34000 minus 8000 gives us 26000 as the profit for second unit or 2 units of the output.

Similarly, for the third unit of output, total revenue is 42000 and marginal revenue is Ra.8000. How do we get the marginal revenue here? It is the difference between the third unit of the total revenue and second unit of the total revenue. So, 42000 minus 34000, that gives us 8000 as marginal revenue for the third unit of the output or for 3 units of the output.

Now, what is the cost over here? Considering unit cost remains constant for 3 units, it should be 12000. So, if it is for 1 unit, it is 4000 and for the third unit, it is 12000, where there are 3 units of output. Marginal cost is same because it is the difference between the third unit of the total cost and second unit of the total cost. So, 12000 minus 8000 and that gives us 4000. Now, what is the profit over here? It is total revenue minus total cost. So, that comes to 30000, that is 42000 minus 12000, that 30000 is the desired activity level. I will talk about the desired activity level a bit later once we understand the table.

Now, for the fourth unit, total revenue is 46000. How we will find out what is the marginal revenue associated with the fourth unit? It is the difference between the total revenue of fourth unit and the third unit. So, total revenue of fourth unit is 46000 and total revenue of third unit is 42000. So, 46000 minus 42000, that gives us 4000, which is the marginal revenue associated with the fourth unit of output. Total cost is 16000 and for 1 unit it is 4000. Considering this as a fixed cost for the fourth unit, this is 16000. Marginal cost is 4000, that is the difference between the cost associated with the fourth unit and the third unit. So, marginal cost is 4000 and marginal revenue is 4000.

Coming to fifth unit, the total revenue is 42000 and total cost is 20000 for fifth unit. For one unit, it is 4000. So, 5 units total cost is 20000. Now, what is the marginal revenue and marginal cost? Marginal revenue is the difference between the fifth unit of total revenue and fourth unit of total revenue. So, this is 48000 minus 46000. So, that comes to 2000. What is the marginal cost? It is constant. It is the difference between the cost associated with the fifth unit of output and fourth unit of output. So, marginal cost comes to 4000 for fifth unit.

Then, it comes to sixth unit. For the sixth unit, the total revenue is 49000. How to find out the marginal revenue? Again, it is the difference between the sixth unit and the fifth unit. So, in that case, if you look at it, there is a difference of 1000 over here as the marginal revenue. Cost is Rs24000 and 4000 as the per unit cost. We are using six units. So, this becomes 24000. So, the marginal cost is the difference between the cost associated with the sixth unit and fifth unit. So, that comes to 4000. Now, what is the profit in the case of fifth unit and sixth unit? Profit is 28000 in case of fifth unit, that is 48000 minus 20000. For sixth unit, it is the difference between the total revenue of 49000 and the total cost 24000, where the profit is 25000.

So, this is a hypothetical scenario, where we are getting whatever is the number of units of output, we are getting total revenue and we are getting total cost, we are getting marginal revenue and we are getting marginal cost. From the difference between the total revenue and total cost, we are getting the profit.

Now, for any producer, what should be the desire activity level and what should be the absolute activity level. Now, what is the difference between the desire activity level and absolute activity level? That is on the basis of the profit and on the basis of the value of marginal revenue and marginal cost. So, if you look at the cost, it remains constant. Marginal cost remains constant and marginal revenue is going on decreasing. It started with 14000 and it reached to 1000. Marginal cost remains constant because the per unit total cost remains constant and that is at 4000.

So, in the first case, the producer is getting profit as 16000 and in the second case, it is 26000 and in the third case, it is 30000. In the fourth case, it is 30000. Now, between the third unit and the fourth unit, one is desire activity level and second one is the absolute activity level. Now, why this is a desire activity level? If you look at in the third unit, still the marginal revenue is greater than the marginal cost. It means the per unit revenue by the third unit is more than the per unit cost associated with the third unit. So, still it is profitable for the produce to go further because by producing one more unit, he is getting the same level of profit. But the marginal revenue is still greater than the marginal cost.

So, when he is operating in the fourth unit, the marginal revenue is 4000 and marginal cost is also 4000. So, this is the point where the marginal revenue is equal to the marginal cost. If the producer is going beyond the fourth unit, then the revenue is

decreasing and cost remains constant. So, the marginal revenue is less than the marginal cost. What does it imply? It implies that whatever the last unit revenue by producing one more unit of the output is the revenue generated at the last unit that becomes less as compared to whatever is the cost incurred by the last unit.

So, marginal revenue is less than marginal cost. Now, what happens in case of second unit or third unit? In case of second unit and third unit, the marginal revenue is greater than the marginal cost. It means, still there is a scope for the producer to produce more because the per unit revenue generated in the last unit is more than the per unit cost associated with the last unit. So, unit four is the point where the marginal cost is equal to marginal revenue. Any unit above this, the marginal revenue is greater than marginal cost and any unit below this, the marginal cost is greater than marginal revenue. So, the choice is between whether the producer is to operate in the third unit or whether in the fourth unit.

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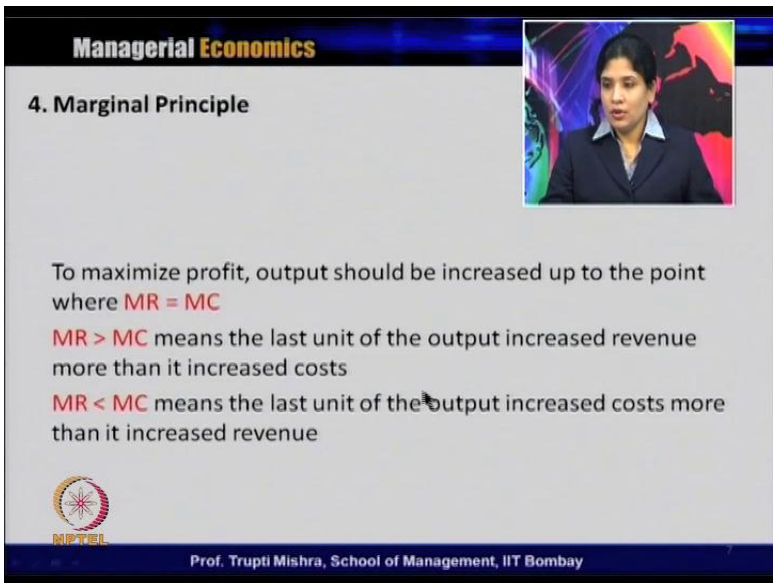

So, using marginal list principle, we will see which one is the ideal level, that is whether it is third unit or whether it is the fourth unit. So, to maximize the profit, output should be increased up to the point where marginal revenue is equal to marginal cost. So, if you are going by this policy or this rule, this marginal revenue equal to marginal cost, that is at the fourth unit, the marginal revenue is equal to 4000 and the marginal cost is equal to 4000. So, at this point, marginal revenue is equal to marginal cost.

So, even if the profit remains same between unit three and unit four, the revenue is more in case of fourth unit. Going by the marginal list principle, in order to maximize the profit, the output should be increased up to the point where marginal revenue is equal to marginal cost.

So, in this case, fourth unit is that level of output what the producer should produce to maximize the profit. So, one possibility is when marginal revenue is equal to marginal cost. There are two other possibilities, where we are getting that at some point or at any level of output, either marginal revenue is greater than marginal cost or the marginal cost is greater than the marginal revenue.

Now, we will check when we are encountering the position or when we are encountering the possibility where marginal revenue is greater than MC and when the marginal revenue is less than MC. What does it imply when marginal revenue is greater than MC? It means, the last unit of output increased the revenue more than the cost. So, this is profitable for the producer to produce more because the last unit of output is generating more revenue than the cost.

Now, what is the other possibility? Marginal revenue is less than marginal cost. It means, the last unit of the output increases cost more than the increase in revenue. So, the cost incurred in the last unit is more than the revenue generated. So, it may not be the profitable for the producer to go beyond this or produce at this level because they are not generating extra revenue. Rather, they are generating extra cost and whatever is the extra revenue they are generating, that is less than the extra cost. So, marginal list principle is always marginal revenue is equal to marginal cost. This is the profit maximization principle. This we are going to follow in case of managerial economics, in order to maximize the profit there should be equality between the marginal revenue and the marginal cost.

So, in the last few minutes, we were discussing about the marginal analysis. So, what is the basic understanding about the marginal analysis? What is the change in the revenue or what is the change in the cost or what is the change in the utility? It is total revenue, total cost and total unit, when there is a per unit change in the output. So, basically marginal analysis deals with per unit change in the variable.

When you take this to a real life example, may be we get some situations or we get some examples where per unit change is not possible. The change is not per unit but the change is junk. If it is a per unit change, sometimes there is a difficulty in evaluating and estimating. So, particularly in those time periods, the change is not per unit but change is in a junk.

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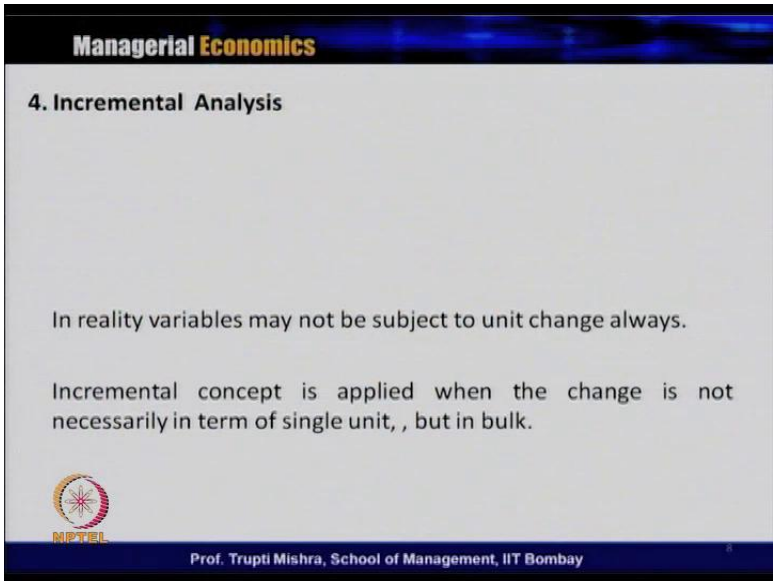

So, in reality, variable may not be subject to unit change always. Specifically at those situations, we need the incremental concept in order to analyze whatever is the change and how it affects the other variables due to this change.

So, incremental concept is applied when change is not necessarily in terms of single unit but in a bulk unit. So, marginal is specifically per unit change. When there is no per unit change, in this case, we use the term incremental concept for the change in bulk and not change in the single unit.

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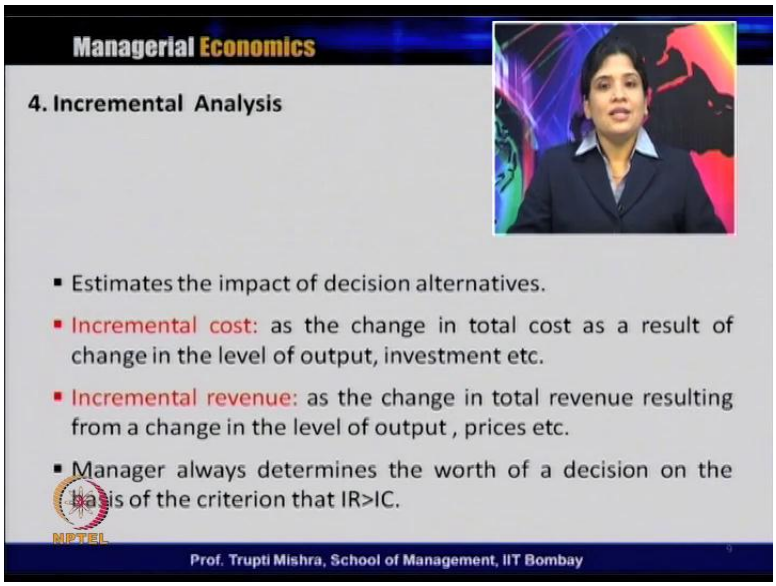

Now, it estimates the impact of decision alternatives. Sometimes, some decisions may not lead to per unit change. The change is in terms of bulk. So, in that respect, incremental analysis estimates the impact of the decision alternatives.

Now, we will check what incremental cost is and what incremental revenue is. Incremental cost is the change in the total cost as a result of change in the level of output or investment, whatever may be the variable. Incremental revenue is the change in the total revenue resulting from a change in the level of output or the price. So, when there is a change in the level of output or when there is a change in the level of price, what is the change in the revenue? That is incremental revenue. Incremental cost is when there is a change in the total cost as a result of change in the level of output or the investment. The manager decides like the marginal list principle. The profit maximization rule is marginal cost is equal to marginal revenue.

Similarly, in case of incremental analysis, how the managers decide whether the decision is profitable or whether the decision is not profitable? Managers always determine the worth of a decision on the basis of the criteria, and that is incremental revenue is incremental cost. So, whatever the decision taken, the outcome should be that incremental revenue should be greater than the incremental cost because of this typical decision or change.

So, if you look at marginal, it also deals with change. Incremental also deals with change. Marginal analysis deals with change for one unit and incremental analysis deals with the unit change in the bulk and not the single unit. So, we will take an example in order to understand the incremental analysis.

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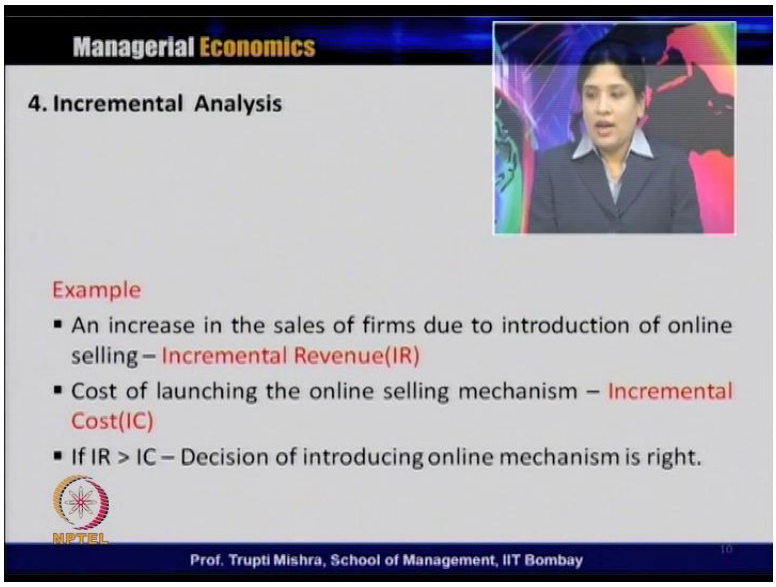

Suppose, a firm decides that they will go for online selling. They feel that if they adopt a strategy, that is if they are going for online selling, it will be profitable for their firm. So, this is one kind of decision taken by the firm. That is, they are going for online selling in order to increase the revenue or in order to increase the sales, which will increase the revenue.

So, after going for online selling, there is an increase in the sales of the firm. Now, what is incremental revenue here? Incremental revenue is that there is an increase in the sales of the firm due to the introduction of online selling. Online selling is the decision. Due to online selling, there is an increase in the sales of firm that leads to increase in the revenue. So, increase in the total revenue due to increase in the sales of firm, and that is incremental revenue.

Now, what is cost here? Cost is launching the online selling mechanism. When they have taken the decision for introduction of online selling, it involves some amount of cost that increases the total cost of product. So, cost of launching the online selling mechanism is

the incremental cost. Increase in the revenue due to the increase in the sales of firm is the incremental revenue.

So, if incremental revenue is greater than the incremental cost, then the decision of introducing the online mechanism is right. Now, the manager, on what basis he will take the call if he should go with the online selling or he should stop it. For him, the decision criteria is that, till the time the incremental revenue is greater than incremental cost, the decision of introducing online mechanism is right and the manager will continue with this decision.

If it is not, then if the incremental revenue is not greater than incremental cost, then the decision is not bringing any profit to the firm and hence, the manger will discontinue this online selling. So, in incremental analysis, the decision rule is incremental revenue should be greater than then incremental cost in order to bring the decision taken by the firm to be profitable.

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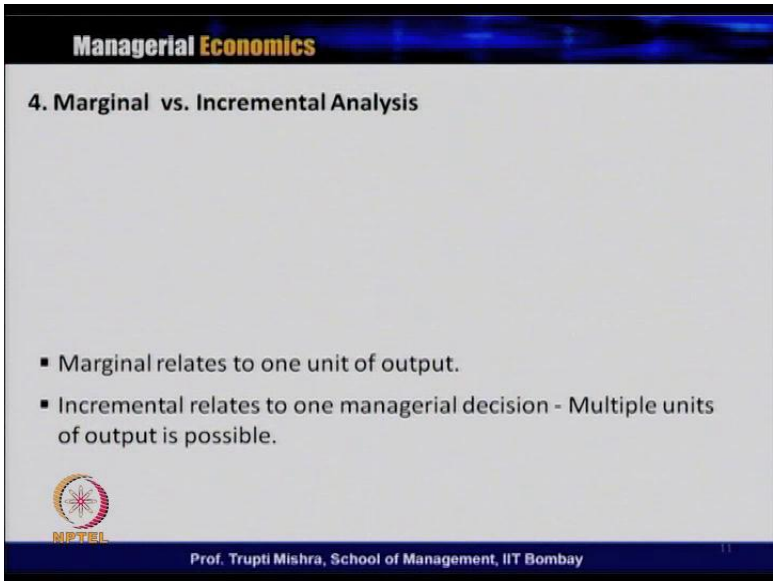

So, as we discussed, if you compare between the marginal versus incremental analysis, always the marginal analysis relates to one unit of output. Incremental analysis relates to one managerial decision. It may involve multiple units of output. So, marginal strictly deals with one unit of output and incremental always deals with the decision, which involves more than one unit of output.

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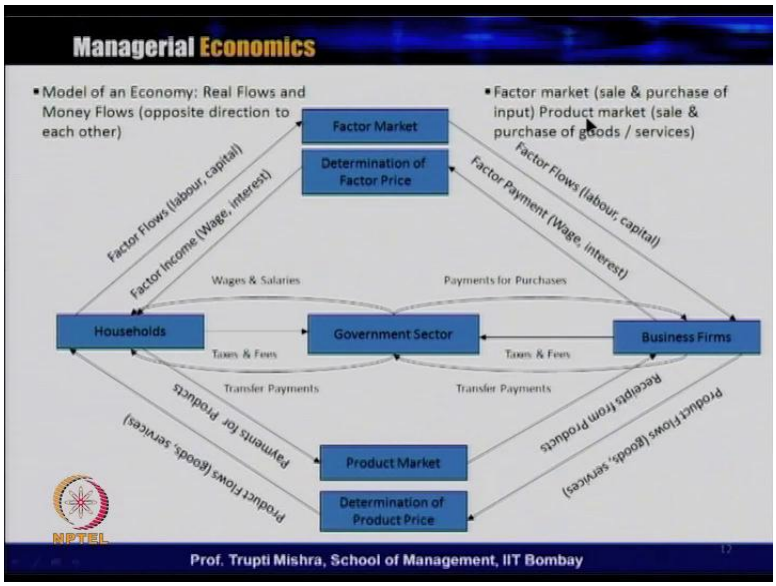

Then, we will come to a typical model of an economy and we will see the different sectors here and how it works or what is the money flow, what is the real flow for each sector and how generally a typical economy works here.

So, if you look at it a typical economy, there are four sectors. One is factor market, second is product market, third is household, fourth one is business firm and fifth one is government sector. So, if you look at it, if you are not considering market as the sector, there are typically three sectors. One is household, second one is government and third one is business firm.

So, household sector basically deals with providing manpower to the business firm and in return they get goods and services produced by the firm what they purchase. Government sector does a transfer payment to both the household sector and the business firm and in return they get tax and fees from both the household firm and the business firm.

So, let us first analyze the flows between two sectors, that is household and the government sector. Now, household provides manpower to the government sector and in return, they get wages and salaries. Now, what the government sector gets out of it is taxes and fees. That is the revenue of the government sector from the household sector.

Now, the sector is business firm. Now, what is the relationship between the government sector and the business firm? Business firm gives a transfer payment to the government and the government pays for their purchases of goods and services produced by the business firm. Also, the business firm gives tax and fees to the government sector, which is their revenue.

Now, what is the relationship between the household sector and the business firm? Households provide the input in terms of manpower to the business firm to produce the goods and services and in return of that, they get wages and salary. What is the outcome of the business firm or what is the output of the business firm? They produce goods and services and sell it in the open market and they get payments for the purchases from the household sector and from the government sector.

So, if you simplify it, household sector and business sector, how they are related? If you are considering it as a two economy, there is only household sector and the business sector. In case of household sector, they provide the manpower to produce goods and services by the business sector and in return, they get wages and salaries from them.

Business sector use the manpower from the household sector and they utilize that for the production of goods and services that they sell to the household sector and in return, they get a payment for their purchases of the goods and services. How household sector and government sector are dependent? Household sector provides manpower to the government sector and in return, they get wages and the salaries.

They pay tax and fees to the government, which is revenue for the government and government sector provides transfer payment to the household in terms of pension and different types of payments benefit. Now, in order to facilitate the sales of goods and services of business firm to the household and the government sector, there is a product market. So, business firm, after producing the product, they send it to the product market in order to sell those goods and services. So, there is a product flow from the business firm to the product market.

Product market determines the product price, which is consumed by the household. So, household buys the product from the product market. There is a product flow of goods and services from the product market to the household. In return of that, household gives the payment to the product market, which goes finally to the business firm, who are the

producer of the goods and services. Now, in order to facilitate the input market or in order to produce the product, the business firm needs certain factors of production or certain inputs, that he gets through to the factor market, rather than getting directly from the household.

So, household provides labour and capital to the factor market, which gets used by the business firm in order to produce the product. Now, the factor market determines the factor price. Since household is providing factors to the business firm, they are getting factor income, which is in terms of wage and interest. So, wage is the payment for labour and interest is the payment for the capital.

Now, after using the factors, labour and capital, the business firm gives back the wage and interest to the factor market, which finally goes to the household as the factor income. So, how factor market and business firm are related? Factor market is facilitating the factor requirement for the business firm, getting it from the household and providing it to the business firm. Business firm using the factor provided by the household, produce the product and give it to the product market. Product market is sending this to the household, that is what the household buys from the product market and gets a payment for it, and that finally goes to the business firm.

So, if you look at it, apart from the government sector, there are two major sectors. One is household and second one is business firm. Household provides the factor input to the business firm and business firm produces the product. The household again buys it from the product market and gives back the price of the product as the income of the business firm. Similarly, what is the income of the household? The income of the household is that, whatever the factors they are providing to the business firm, the payment made for that, such as, if they are providing labour, it is wage and if it is providing capital, then it is interest.

So, if you look at it, the income of the household become expenses of the business firm and the income of the business firm becomes the expenses of the household. So, all the sectors are interrelated with each other when it comes to the economic activity of the economy. Government sector is there and it is interlinked with both the household sector and the business firm. They provide transfer payment to household sector and get the transfer payment from the business firm. They do purchases from the business firm and

make a payment for it. They take the help of the manpower to operate the government sector and in return, they pay wages and salaries to the household.

What is the revenue of the government sector? Whatever tax and fees they get from the household sector and the business firm becomes the income of the government sector. So, basically there are three sectors. One is household sector, second one is business firm sector and third one is the government sector and all the three firms are related with each other.

There are two markets. One is factor market that deals with sales and purchase of the input. The second market is product market that deals with sales and purchase of the goods and services. So, business firm sell their products through the product market and get their factors through the factor market. Household sell their factors through the factor market and buy their product from the product market.

Now, there are two kinds of flows here. One is real flows; that is the real transfer of goods and services from product market to household and the real transfer of labour and capital as factor flow from the factor market to business firm. The second kind of flow is money flows. It is the real transfer of income from factor market to household in terms of factor income and real transfer of income from product market to business firm, that is from the payment of the product made by the household sector.

So, there are inter linkages between all these three sectors. The two markets which facilitates the transaction, one is factor market and second one is product market. So, whatever we discuss in the last class and this marginal analysis, few opportunity costs, few other concepts, and this marginal and incremental analysis, these are the session references. Then we will move to our next topic and that is basic tools of economic analysis and optimization technique.

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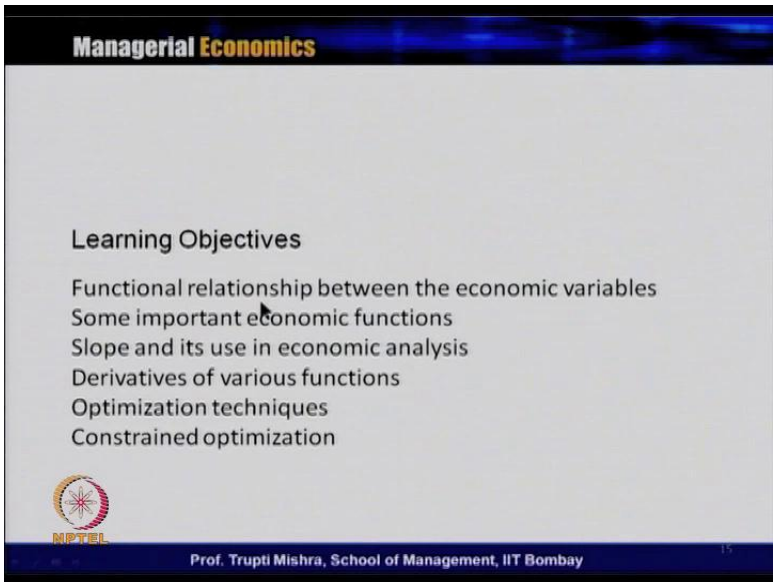

Now, what is the learning objective or session outlines of this topic? We will first look at what is the functional relationship between the economic variables and then we will discuss some important economic functions. Then we will see slope and its use in the economic analysis and derivatives of various functions, optimization techniques and finally, how we do optimization with a constant.

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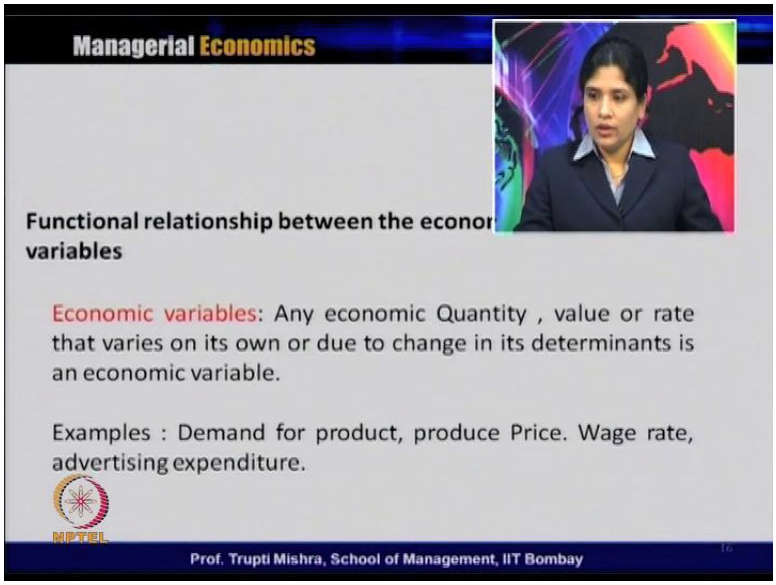

So, now coming to the relationship between economic variables. Now, what we consider as an economic variable? Any economic quantity, value or rate that varies on its own or

due to change in its determinants is an economic variable. Any economic quantity or value or the rate, the variables rate, any variable whether its value or rate that changes due to its own or due to change in the determinants of each is an economic variable.

So, when the variable changes the value due to its own value or due to some other factors, those are considered as economic variables. We can take the example as demand for a product whether it is 10 units or 12 units or 13 units, every time it is changing a value. The demand is not constant. So, this is an economic variable.

Price of the product, wage rate, and advertising expenditure are few more examples of the economic variable, where the value get changed either due to own factors or due to change in the determinants, that is the factors affecting the demand for the product.

Suppose you take an example like why there is a change in the product price or why the price of goods increases, when the cost of production increases. Suppose you take the case of this marker, the cost of production is 10 rupees. So, price is on the basis of 10 rupees. When you add a normal profit and a tax with this, it becomes the market price for this marker. Suppose the market price of this marker is 13 rupees and out of this, cost of production is 10.

So, what is the determinant of this price of this marker? The cost of production. Now, on what basis there will be an increase in the market price of this marker? When there will be an increase in the cost of production. Suppose, the increase in the cost of production has become from 10 rupees to 11 rupees. So, the market price given all other factors, the value of all other factors remains constant, and the market price of this marker will go up by 1 rupee. So, if it is 13 rupees, now it is 14 rupees. So, product price in this case, the product price is changing due to change in the value of its determinants. So, this is one example of the economic variable.

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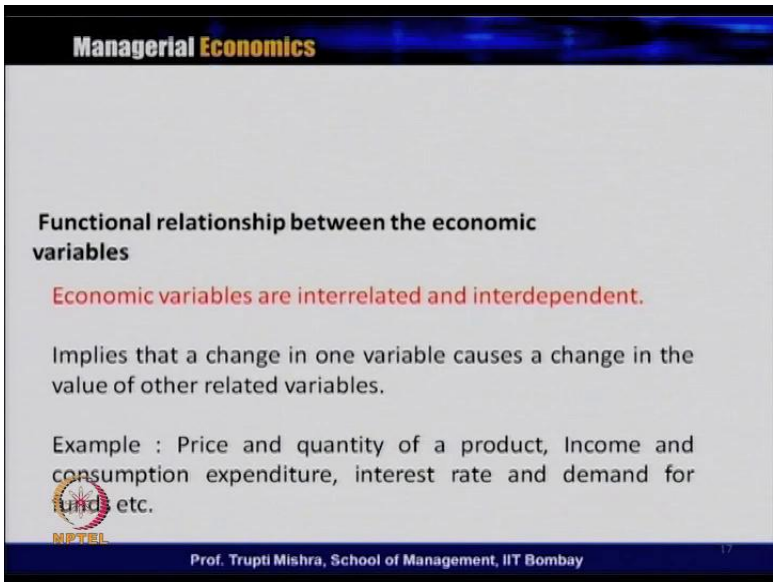

Now, all these economic variables are interrelated and interdependent. All economic variables are not independent but they are interdependent and they are interrelated. This implies that a change in one variable cause a change in the value of other related variables. If they are interrelated or interdependent, when value of one variable changes, generally that leads to change in the other variable.

Suppose, we take an example of price and quantity of a product. If you take the same example, that is price of marker, earlier the price of marker was 13 rupees. Due to change in the cost of production, the price of marker is 15 rupees. Now, price and quantity of product, they are interrelated. The price is more. Now, if it is from 13 to 15 rupees, few customers who cannot afford to pay 15 rupees for that, they will not buy this product. So, this increasing price affects the quantity of the product what is getting sold in the market.

So, price increase leads to decrease in some quantity of product that is getting sold in the market. So, if we look at price and quantity of product, they are interrelated. Because of that, when there is a change in the price or when there is a change in the value of one variable, that leads to change in the value of the other variable.

In this case, typically the price of marker gets changed and that leads to change in the quantity of the products getting sold in the market. Similarly, income and consumption expenditure. Suppose, if your income is more, you consume more and you spend more.

If income is less, you spend less. So, if you look at income and consumption expenditure, they are interrelated. So, value of one gets changed, due to change in the value of the others.

Similarly, interest rate and demand fund. If the interest rate is less, more people go for loan. If the interest rate is high, there is at least decrease in the demand for loans because the interest rates are on the higher side. So, economic variables are interrelated and they are interdependent. When there is a change in the value of one variable, that leads to change in the value of other variables because both of them are interdependent and interrelated.

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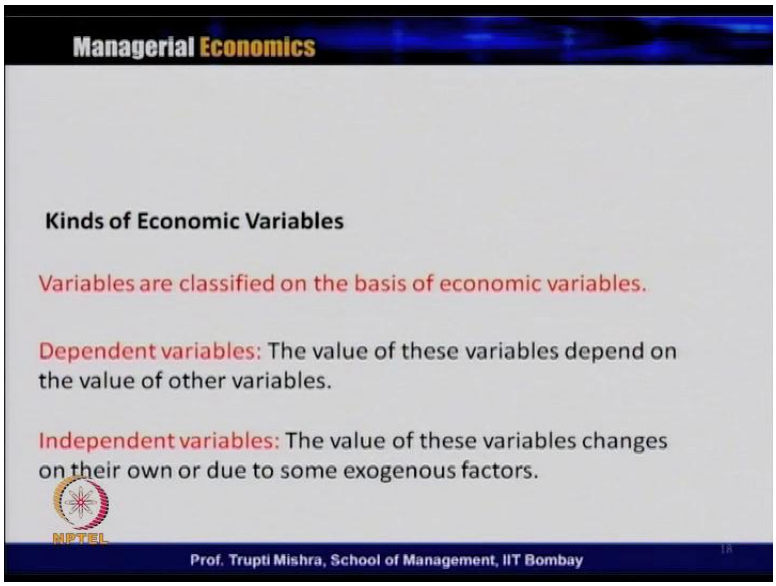

Now, what are the different kinds of economic variable? Variables are classified on the basis of economic variables. So, the first category is dependent and independent variables. The value of this variable depends on the value of other variable in case of dependent variable. Independent variables are those where the value of these variables changes on their own or due to some exogenous factors.

So, dependent variable is one where the value of this variable is always dependent on the value of the other variable. Independent value is the value of this variable changes due to their own or may be due to some exogenous factors, but not due to change in some other variable.

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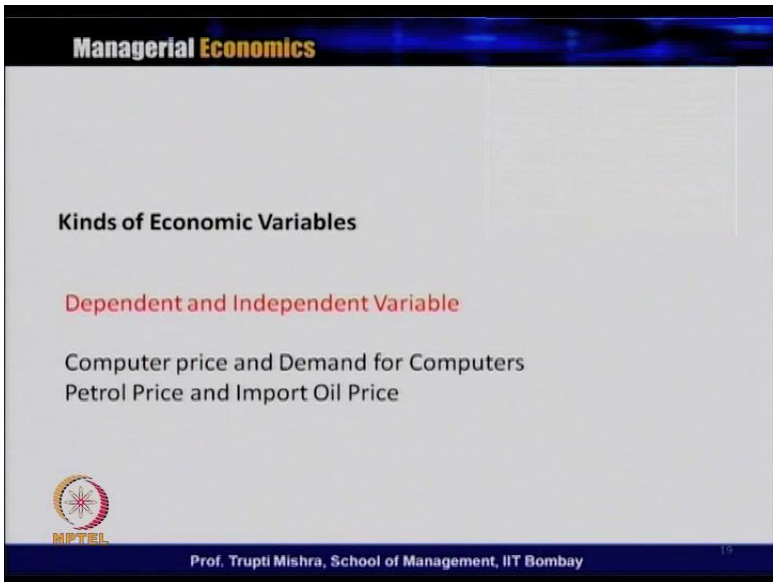

So, you can take the example of computer price and demand for computers. Here, demand for computers is dependent and computer price is independent because demand for computers is dependent on the computer price. When there is an increase in the computer price, it leads to decrease in the demand for computers. When there is a decrease in the computer price, it leads to increase in the demand for computers.

So, in this typical case, the computer price is the independent variable and demand for computer is the dependent variable. Similarly, there is an increase in the petrol price. Nowadays, there is an increase in the petrol price. Why there is an increase in the petrol price because there is a hike in the import oil price.

So, in this case, which one is dependent and which one is independent? Petrol price is a dependent variable, because petrol price is related with the value of the import oil price. Whenever there is a change in the import oil price, either increase or decrease in the import oil price, and that leads to change in the value of petrol price. So, if there is an increase in the input oil price, that leads to increase in the petrol price. If there is a decrease in the import oil price, that leads to decrease in the petrol price. So, in this case, petrol price is dependent and input oil price is the independent variable. So, dependent variable is one where the value of that variable is dependent on the other variables. Independent variable is one where it is not dependent on any other variable for its value, rather the value changes due to own or due to the exogenous factor.

The second kind of economic variable is endogenous and exogenous variable. Now, what is endogenous variable? Endogenous variables are those where the value of these variables is determined within the framework of the analysis model. So, if there is a model between price and quantity, the endogenous variable is one where the value of price or value of quantity has to be determined within this specific framework or specific model. Exogenous variables are those where the value of these variables are determined outside the framework of the analysis model. So, any exogenous factor or any external factor will decide what is the value of this exogenous variable.

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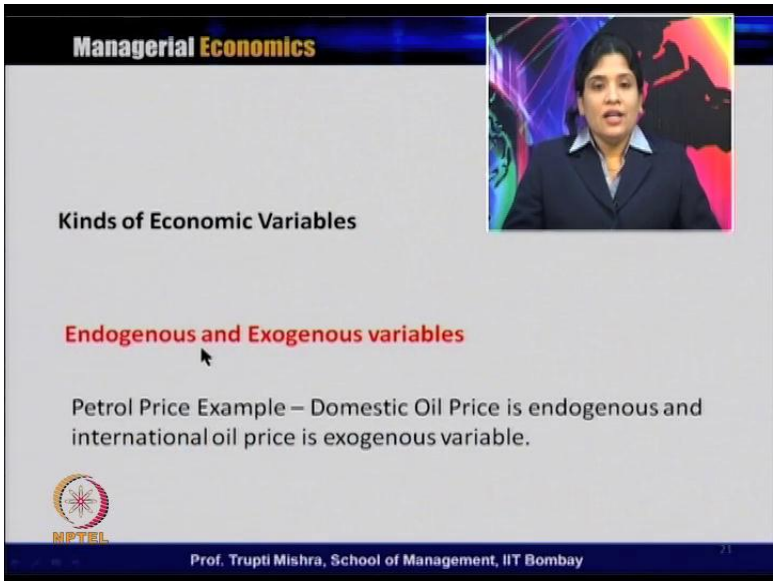

Now, we will take the example of the endogenous and exogenous variable. If you are going to the same petrol price example, domestic oil price is endogenous and international oil price is exogenous variable. So, domestic oil price is dependent on the import oil price. So, in this case, the value of the domestic oil price is decided within the framework from the import oil price. However, exogenous variable is international oil price. International oil price is not strictly on the basis of the import oil price. It has some other factors and the value, those other factors also decide whatever is the international oil price. So, in this case, domestic oil price is the endogenous variable, whose value is determined within the framework and international oil price is the exogenous variable, whose value is decided on the basis of the external factors.

Now, when we analyze the relationship between the variables, we can analyze this or we can present the relationship between these variables through three methods. One is tabular method, second one is functional method and third one is the graphical method.

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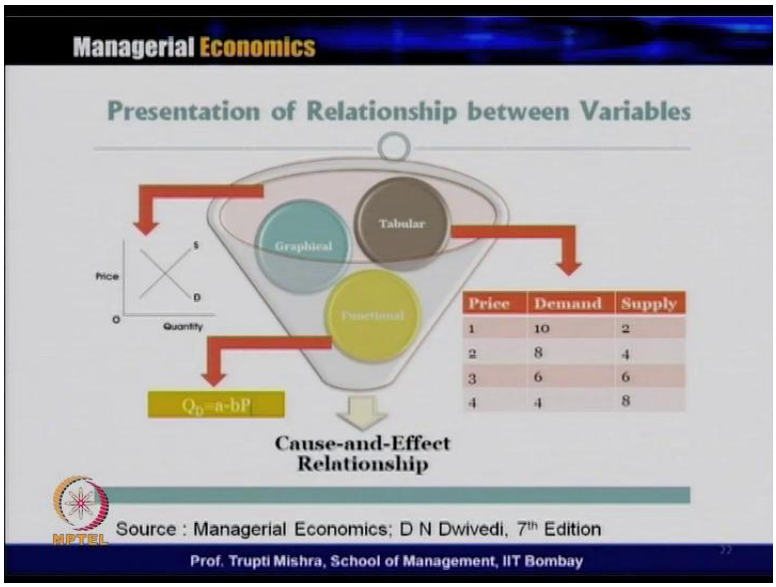

So, take the example of price, demand and supply. Suppose, there are three variables. This relationship between price, demand and supply can be presented through a graphical analysis. That is, through a supply curve, and through a demand curve taking quantity in the right axis and price in the left axis. We can do a tabular, where we can find out what is the demand and supply when the price is 1 rupee, 2 rupees, 3 rupees and 4 rupees. So, this is the tabular representation of the relationship between the variables and this is the graphical relationship between these variables and third one is functional, which deals with the cause and effect relationship, which we analyze or which we present through a functional form.

So, in this typical example, when we are deciding the relationship between demand and price, it will take a functional form, which is equal to Q d which is equals to a minus b P, where a and b are constant and P is the price of the product and Q is the quantity demanded for this product. So, relationship between these three variables can be presented through graphical method, through tabular method or through the functional method.

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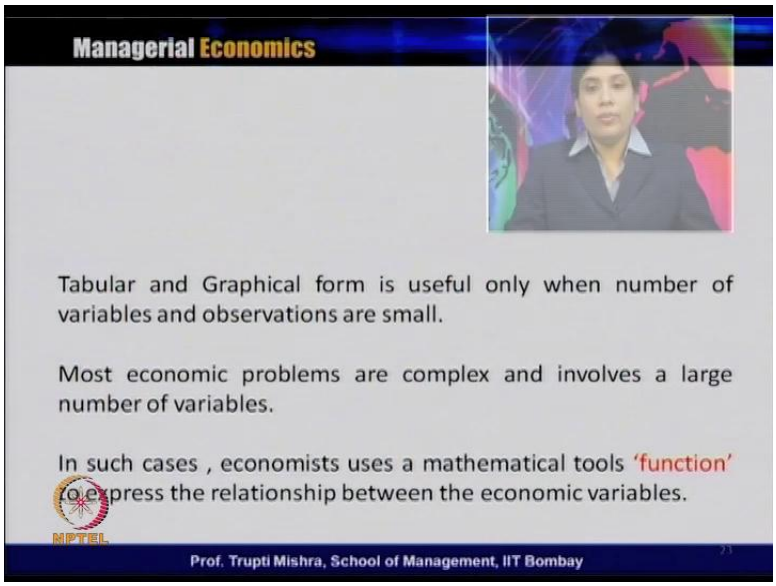

So, tabular and graphical form is useful when number of variables and observations are small. If it is two or three variables, then tabular and graphical form can be used. But if the number of variables is more, specifically in case of economic analysis, all the economic variables are interrelated and interdependent.

So, the number of variables and the number of observations are more. So, in this case, it is always good to use the functional form in order to represent the relationship between these variables. So, most economic problems are complex. It involves large number of variables because they are interrelated and interdependent. In such cases, the economist uses a mathematical tool known as function to express the relationship between the economic variables. So, the tool is functional and we generally call it as a functional representation of relationship between the economic variables. Economic analysis is more useful because there are large numbers of variables. Next, we will see what is a function because function is used to represent the relationship between different economic variables.

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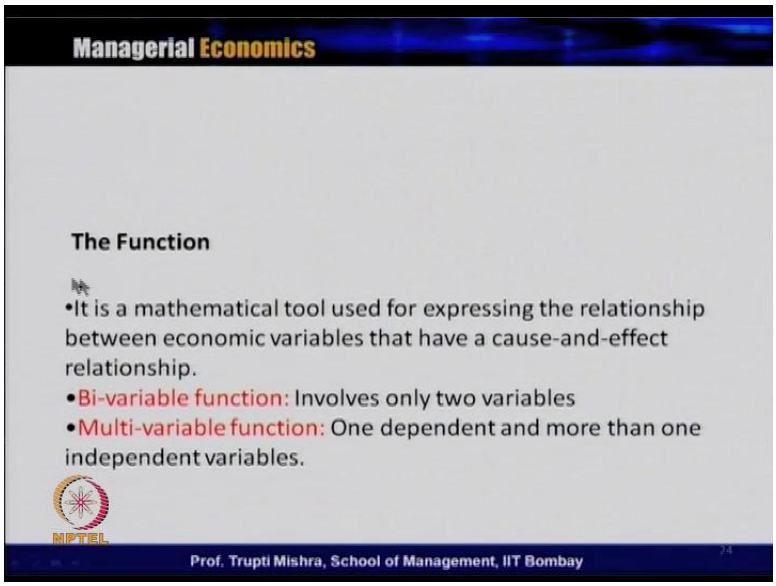

So, it is a mathematical tool used for expressing the relationship between economic variable that have a cause and effect relationship. When they are interrelated, if one is cause and other is effect and it is the relationship between different economic variables. It is a mathematical tool. Function is a mathematical tool used for expressing the relationship between the economic variables.

There are two types of functions. One is bi-variable function and second one is the multi-variable function. Bi-variable function involves only two variables and multi-variable function has one dependent and more than one independent variable. In case of bi-variable function, it has only two variables. One is dependent and another is independent. In case of multi-variable function, there is only one dependent and more than one independent variable.

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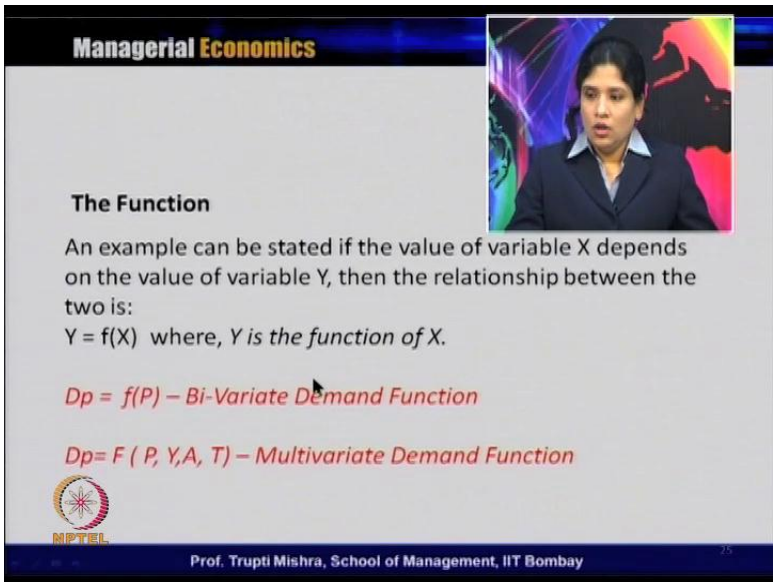

Now, we will take an example to understand this bi-variate function and multivariate function. If the value of variable X depends on value of variable Y, then the relationship between the two is, Y is a function of X, where Y is the dependent variable and X is the independent variable. So, this is a typical function, which expresses the relationship between Y and X, where Y is the dependent variable and X is the independent variable and Y is the function of X.

Now, taking the example of a demand function. If you consider P is the price of the product and d P as the demand for the product, the demand for the product is always dependent on the price for the product. So, in case of your bi-variate demand function, we are taking that there is only one dependent variable and one independent variable. In this case, we use this function d P, f is a function of P and this is a bi-variate demand function, where the demand for the product is dependent only on the price.

Now, suppose we assume that demand for the product is not only dependent on the price. It is also dependent on the income, which is represented through Y, dependent on A, that is advertising expenditure and also depending on the taste and preference of the consumer.

So, in this case, how we represent the relationship between the variable price, demand for the product, income, advertising expenditure, and taste and preference of the consumer through a function. We know that demand for a product is dependent on price

for the product, income for the product, advertising for the product and taste and preference for the product. So, demand for the product is a function of price, income, advertising expenditure and taste and preference.

So, this is the example of a multivariate demand function, where there are four independent variables and one dependent variable. Here, the dependent variable is d P and it is dependent on four independent variables. That is, P ,Y ,where P is the price of the product, Y is the income of the product, A is the advertising expenditure associated with the product and T is the taste and preference of the consumer for the product.

So, there are two types of functions. One is bi-variate and the other is multivariate. Bi-variate essentially deals with two variables and multivariate deals with one dependent variable and number of independent variables.

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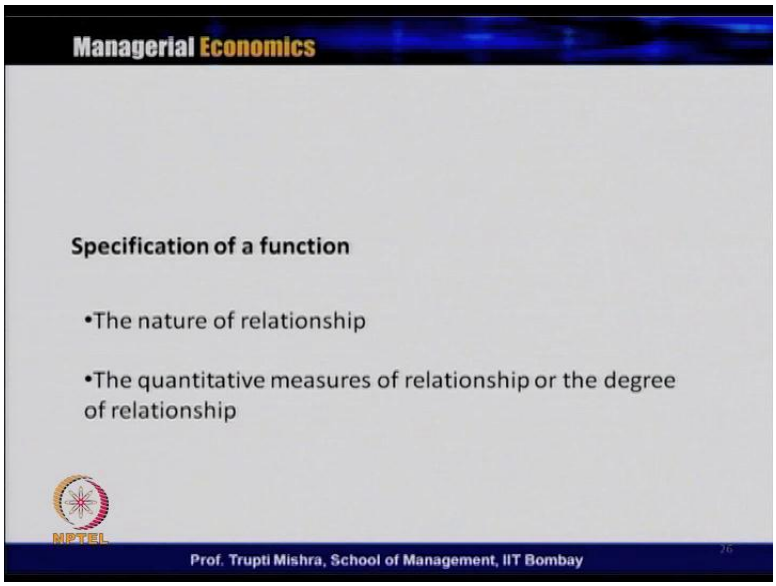

Now, how do we specify a function? It is on the basis of the nature of the relationship. How both of them are related? Whether they are positively related or whether they are negatively related? Second one is on the basis of quantitative measure of the relationship or the degree of relationship, if they are positive. If they are negative, up to what extent. How we can quantify the degree of relationship? That is, on that basis we can specify a function.

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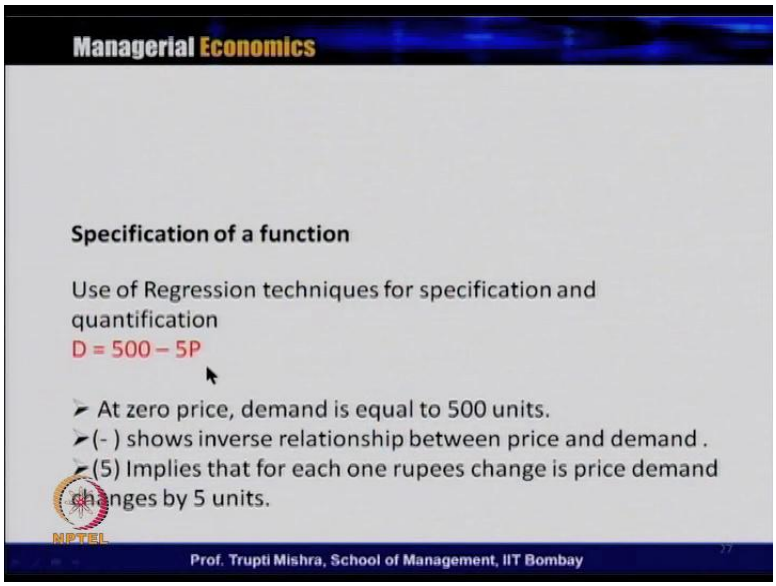

Generally, we use a regression technique for specification and quantification. Now, look at this example. Suppose, we take a demand function, which is 500 – 5P. What are the different implications of this demand function or how we can analyze this demand function? When the price is 0 and demand is equal to 500 units because the intercept value is 500. So, the first implication is at 0 price and demand is equal to 500 units. There is a negative 5P. So, negative source. There is an inverse relationship between price and demand.

This nature of relationship between price and demand is inverse. The value 5 implies that, for each 1 rupee change in the price, demand changes by 5 units. So, 1 rupee change in the price leads to 5 units change in the demand. So, this is the degree of relationship between the price and quantity demanded.

So, at 0 price, demand is equal to 500 units. So, when you get the product for free, the demand is 500 units. What is the significance of this minus? This shows the nature of the relationship between two variables. Nature of relationship is inverse. There is an inverse relationship between the price and the demand and 5 implies that, for each 1 rupee change in the price, the demand change is by 5 units. So, if you look at it, there is 5 times change in quantity demanded, when there is a onetime change in the price. This is the quantification of the relationship or the degree of the relationship.

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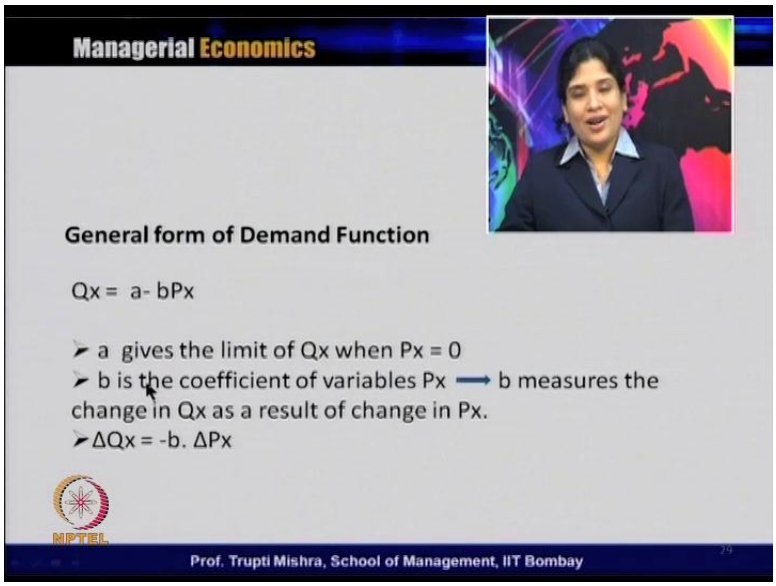

Now, what is the general form of a demand function? The general form of a demand function is Q x is equal to a minus b P x where Q x is the quantity of X, P is the price of X and a and b are the constant. So, constants in a function are called the parameters of the function. What is the role of these parameters? The parameters of the function specify the extent of relationship between the dependent and independent variable.

So, this a and b, they will specify what is the extent of relationship between the dependent and independent variable. They will talk about the nature of the relationship and the degree of relationship between dependent and independent variable.

So, taking this demand function, Q X is equal to a minus b P X, here constant a gives the limit of Q X, when P X is equal to 0 and b is the coefficient of variable P X, which measures the change in the Q X as a result of change in the P x. So, this is basically the change in the Q X, which is equal to minus b and the change in the P x.

So, in the previous example, if you remember, d was equal to 500 minus 5 P. So, 500 was the value of a, which gives the limit of Q X, when P X is equal to 0. So, when price was equal to 0, 500 was the quantity demanded and b is the coefficient of the variable P x. So, if you look at it, in the previous example it was 5 P. So, 5 P is the value of b, which is the coefficient of variable P X, which measures the change in the Q X as a result of change in the P X. It was 5 times because the change in the Q X was 5, which we can get through the value of b and change in the P X is 1. So, in the previous

example, when there is a onetime change in the price that leads to five times change in the quantity demanded.

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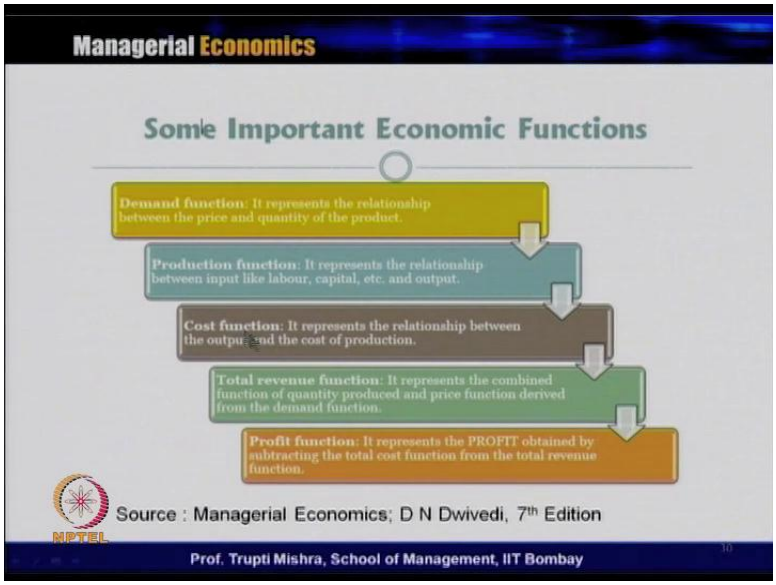

So, there are few other functions like demand function and other thing, like production cost function, that we will discuss in the next session. And for this specific part like basic optimization technique in basic economic analysis, we followed this Managerial Economics by D. N. Dwivedi, 7th edition. Thank you.