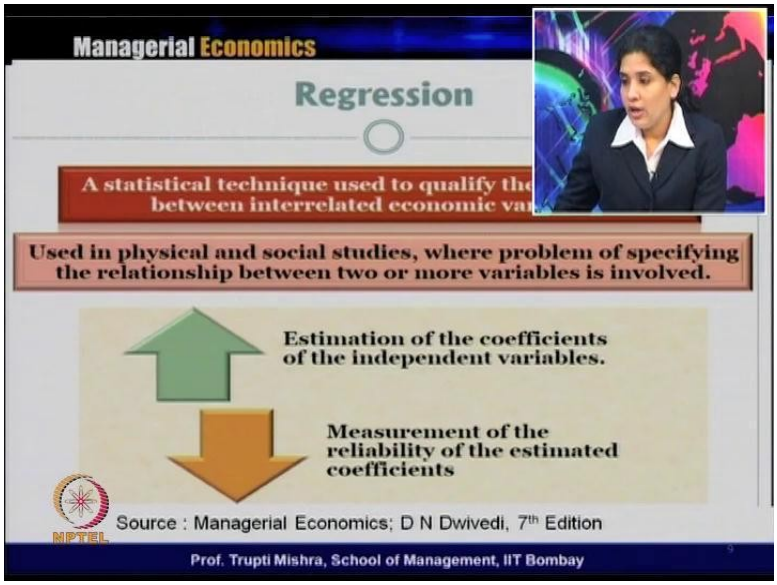
Managerial Economics
Prof. Trupti Mishra
S.J.M School of Management
Indian Institute of Technology, Bombay

Lecture -12

So, now we will move to a new kind of technique; regression technique, that generally used, again to understand the relationship between the two variables, two economic variables. And what are the things, what we are going to discuss in case of a regression technique. We will talk about a nature of managerial problem, and here there again the use of function, how we use the regression technique. Then we see how to formulate a function, so that we can estimate with the regression technique. Then we do an estimation of a linear function using the regression technique, and also we will see the multivariate regression and few taste in the multivariate regression estimate.

(Refer Slide Time: 29:12)

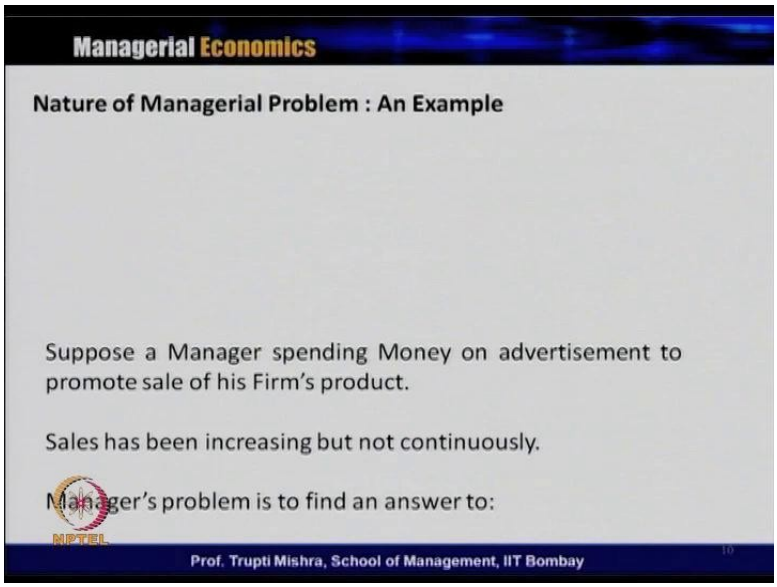


So, before going to the regression techniques and method to solve, or method to get the value through it regression technique, now we will understand, what is a regression? So, regression is a statistical technique, used to qualify the relationship between the interrelated economic variable. So, we know that economic variables are interrelated, and there are number of methods may be through graph, through function, or through may be the mathematical relationship, we always explain the value of the economic variable. So, regression technique is a mathematical technique, what basically quantify the relationship between the two

variables. So, in general sense, we always say that two variables they are positively related or the negatively related. So, regression technique is one step ahead of this, and it gives the exact magnitude of relationship between two variables, that how they are related, even if they are related positively or negatively, what is the extent of relationship, what is the magnitude of relationship?

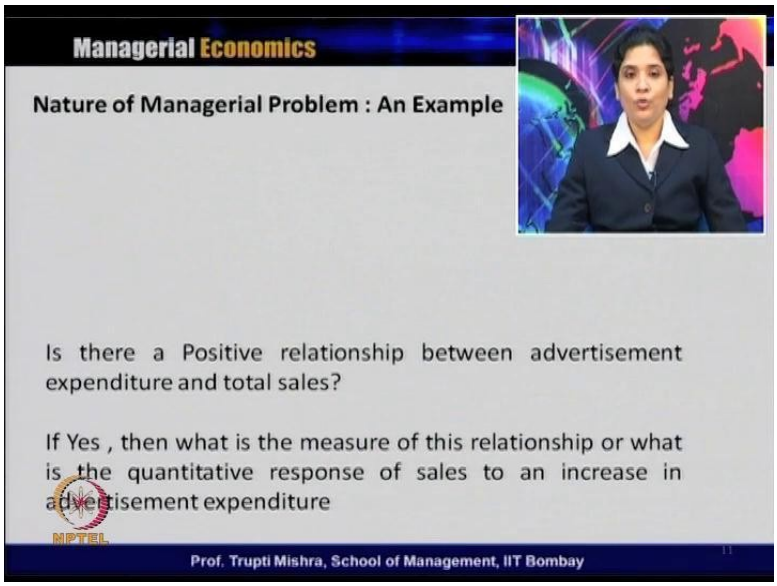
So, regression technique, that is why regression is the statistical technique or the mathematical technique, used to quantify the relationship between the interrelated economic variable. It is generally used in physical and social studies, where the problem of specifying the relationship between two or more variable is involved. So, either it used in the physical, or it is used in the social studies. And particularly in this case, where the relationship is, whether may be the problem is to specifying the relationship, or specifying the magnitude of relationship between two or more variables. Now, here in the regression technique what we do. We do the estimation of coefficient of the independent variable, and also we do the measurement of the reliability of the estimated coefficient. So, using the regression technique, the first step is to estimate the coefficient of the independent variables, and the second one is the measurement of the reliability of the estimated coefficient.

(Refer Slide Time: 31:17)



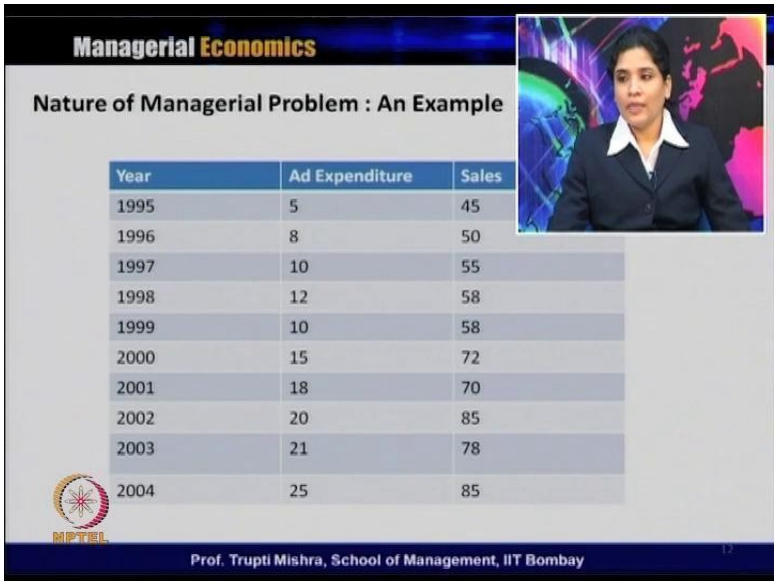
So, before getting into the regression technique, let us understand, may be in what kind of managerial problem we need to use the regression technique. Or where is the case where we use the regression technique, in order to understand the relationship between the two variables. Let us take an example, suppose a manager spending money on advertisement to promote sales of his firm's product. So, manager is spending money on advertisement on promotional activity to promote the sale of his firm's product. Reacting to this, spending money on advertisement, sales has been increasing, but not continuously, sometimes it is increasing more, sometimes it is increasing less and some time it is constant. Now, here what is the managerial decision problem or what is the nature of the managerial problem.

(Refer Slide Time: 32:15)



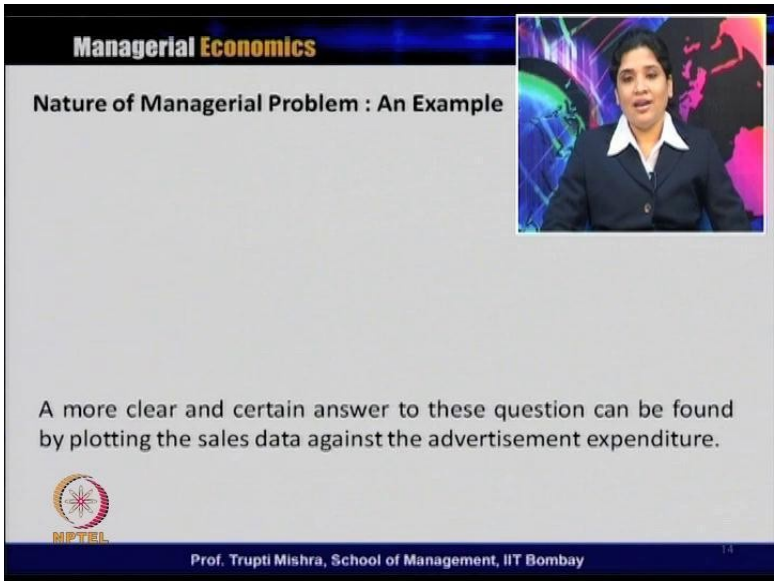
The managerial problem here is to find an answer to, is there a positive relationship between the advertisement expenditure and the total sales, because the manager is spending a good amount of money on the advertising expenditure. The first question always comes whether it is affecting positively to the total sales. Second one if at all it is affecting positively to the total sales, then what is the measure of relationship, or what is the quantitative response to the sales, to an increase in the advertising expenditure. So, first one is, how they are related, and that always we have discussed, and always we can represent in the different form. Here the focus is the second one, what is the measure of the relationship or what is the quantitative response of sales, to an increase in the advertisement expenditure.

(Refer Slide Time: 33:07)



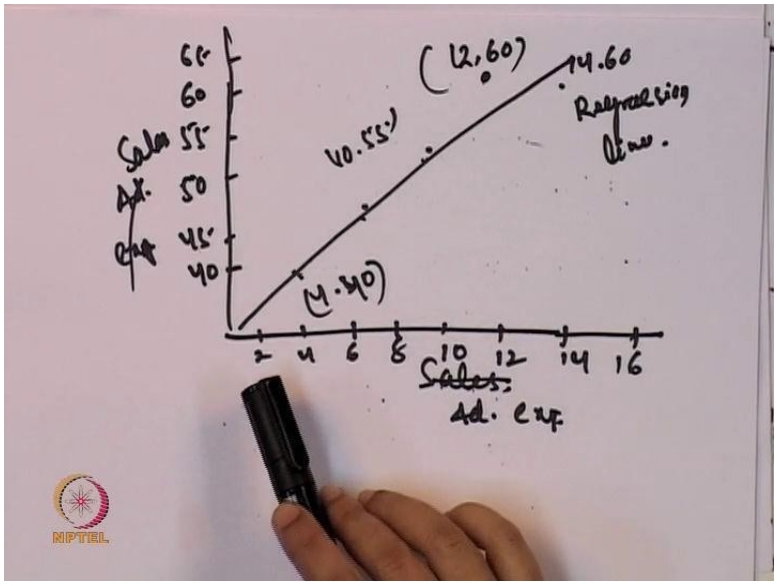
So, this how we can do, maybe we take the data from the, in a specific time period. Or maybe we take a time series data and there we can say, how the advertisement expenditure and the sales they are related. So, if you look at in the table; the first one gives a time line in term of the year, second one is the advertising expenditure, and third one is the sales. So, if you look at in different years, the advertising expenditure there is some amount of money it is going on increasing or sometimes it is. If it is look at, it is going on increasing from 5 to 8, 8 to 10, 10 to 12 and so on and so forth. And the sales also, it is going on increasing, but if you look at the increase in the sales is not may be on a increasing manner; sometimes it is increasing, sometimes it is increasing less, sometimes its increasing high, or sometimes it is increasing, maybe it is just constant. So, if you look at between the year 1998 and 1999, the sales is remain constant, even is the may be the expenditure has increase or the expenditure has decreased.

(Refer Slide Time: 34:20)



So, in this case in order to understand this, may be how to plot it, or how to, may be presented this kind of relationship. So, may be a more clear and certain answer to this question can be, find out by plotting a sales data against the advertisement expenditure. So, whatever we have shown in the previous graph, may be previous table, maybe we can represent that in a graph and we can say that, whether is a clarity that what kind of relationship, between the advertisement expenditure and the sales, whether it is positive whether it is negative; that is getting address the first question. And the second one is, how they are related; like whether what is the magnitude of relationship, whether the advertisement expenditure is increasing, and correspondent with that there is more increase in the sales, less increase in the sale, or what is the percentage change in the sales?

(Refer Slide Time: 35:22)

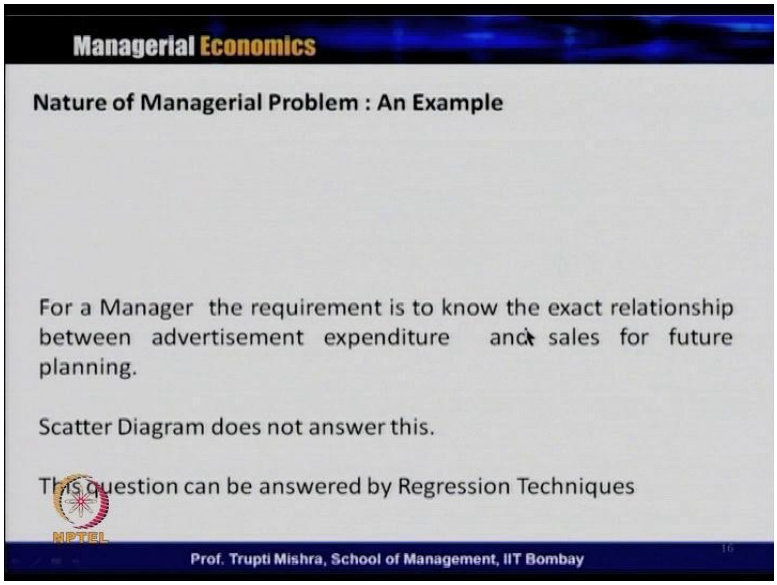


So, if you plot this in a scatter diagram. So, maybe we take sales on the x axis, and advertisement expenditure on the y axis. If you can plot it, then its 2 4 6, may be 8 10 12 14 16. Similarly, we can say 40 may be 45 50 55 60 65. So, now if you look at, maybe you take a specific year. Specific year may be the sale is 6, sales is 8, sales is 10, or sales is that and this is. There is a small change over here, maybe we are taking the add expenditure over here, and we are taking the sales over here. So, if you can plot it, then maybe this is a point, where the advertisement expenditure is 4 and the sales is 40. Similarly, maybe we are taking one point here; that is 8 and 50 point over here; that is 10 and 55.

So, if you look at, each combination gives us a, combination between the, or each point gives us a combination between the advertisement expenditure and the sales. So, similarly may be this is a point, where it is 10 is 55 or we get a combination over here that is 14 and 16. So, if you draw a line over here, this is basically the regression line. So, regression line is used for what, may be this regression line what we can say, or this is the line where, there are different combination of sales and advertisement expenditure. It is not clear that all the point will be on the same line, there are possibilities that, there may be one combination, where the advertisement expenditure is 12, and the sales is 60. So, in that case this is the combination; that is supposed 12 and 16. So, if you look at this combination is this point is not line on the regression line. So, if you put it in a scatter diagram.

So, this is what, this representation is generally called as a scatter diagram, and if you put this in a scatter diagram, it shows a relationship between two variable and again it is not sure, that when the advertisement expenditure moves from 2 to 4 or 4 to 6 or 8 to 10, what happens to the exactly the change in the sales from 40 to 45, 45 to 50 or 50 to 55. What is the exact nature of change, between the advertisement expenditure and the sales. So, scatter diagram, just we are doing a graphical representation of what we presented on the table, and it gives the different, may be combination, and each combination gives you a data on the advertisement expenditure and the sales. So, the primarily how the manager solve this problem, primarily manager solve this problem, by plotting it in a scatter diagram and they generally say that how they are related, but the question comes here, that whether through the scatter diagram, or whether through this table, or whether through this real data and real information, we get the exact nature or exact relationship between the two variable, and in this case typically the advertisement expenditure and the sales.

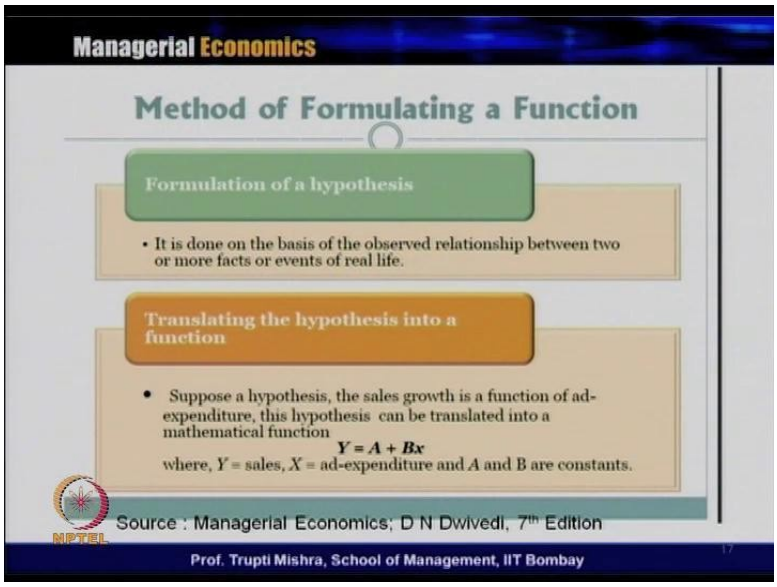
(Refer Slide Time: 39:06)



May be the answer is no, because it is not shows the exact relationship between the advertisement expenditure and the sales of future planning. Neither scatter diagram nor the real life examples, or not the real life data generally gives this answer. So, this question can be answered by the regression technique, and particularly in this case we use the regression technique, and regression technique gives the exact magnitude of relationship. The exact relationship between the two variables, those are in question, maybe it is, in this case may be this is the advertisement expenditure and the sales. Now, for the regression technique, again

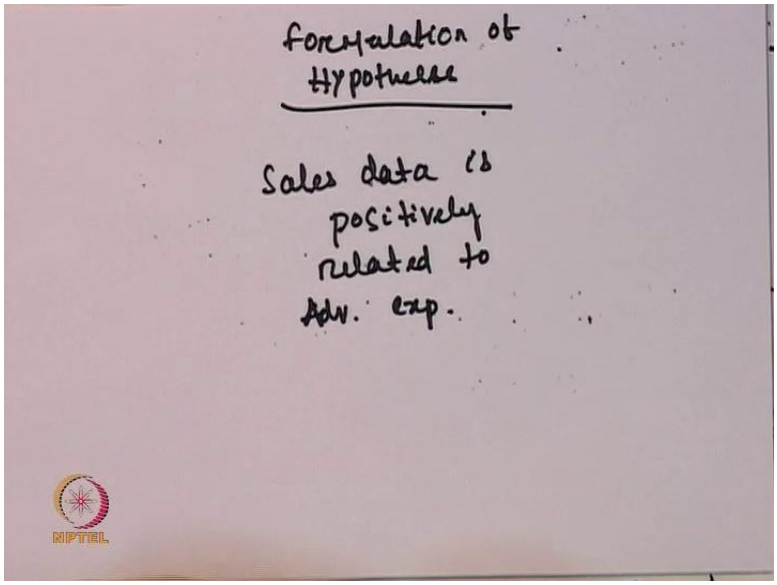
there are two steps. So, we have already understood, what is a regression technique? So, regression technique is one, which gives a quantification to the relationship between two economic variables.

(Refer Slide Time: 40:10)



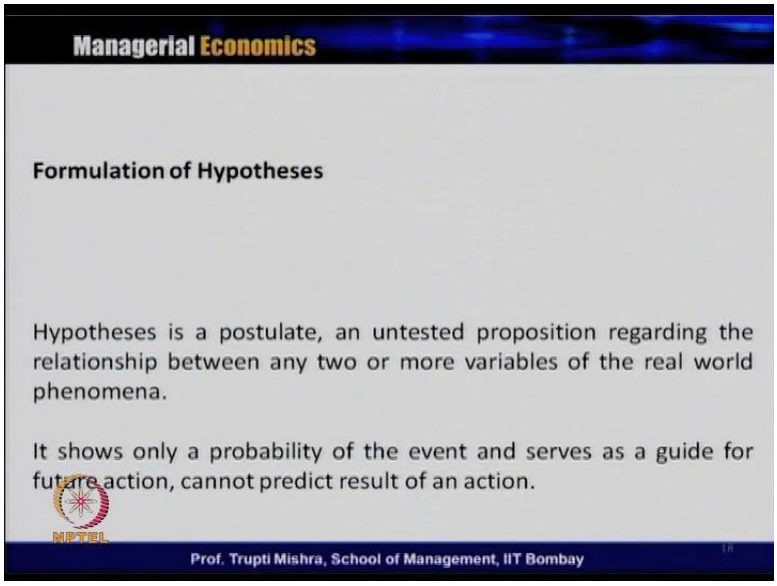
And how they do that, they follow two steps for that; one, initially they formulate a hypothesis, and it is done on the basis of the observed relationship between two or more facts or the events of real life. And second one, they translating the hypothesis into a function, and finally they evaluate, or finally they value the function in order to get the value of the data. So, there are two steps; one is formulation of the hypothesis, and second one is the transforming or the translating the hypothesis into a function. So, we will see the first one, how generally the hypothesis is being form, or how there is a formulation of the hypothesis.

(Refer Slide Time: 40:53)



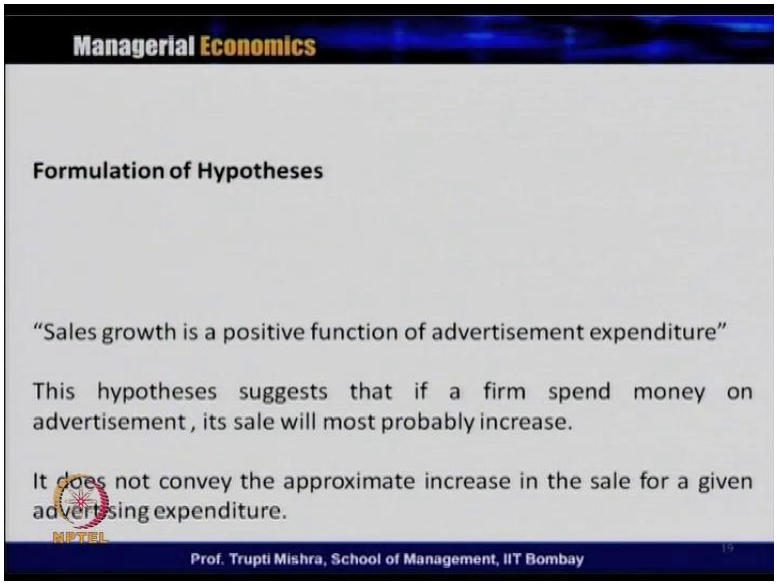
So, hypothesis is, if you look at, it is not may be a relationship between the two economic variable, rather it is a estimated relationship between two variable at, it is a probability that this two variables can react in a certain way. But the result is not known here, the result is unknown here. Suppose, we are saying here for example, advertising expenditure and sales growth, they are positively related. So, this is a hypothesis, this is statement on the basis of the observed data. We do not know that what is the outcome or what can be the result, whether it gives a positive relationship, or whether its gives a negative relationship. So, this hypothesis is one kind of verbal statement, from where generally we formulate a hypothesis, we formulate a function. We evaluate the function in order to note the exact relationship between these two variables. So, we will start with a formulation of hypothesis, generally how we formulate a hypothesis. So, here what means, take the hypothesis, we take the hypothesis sales data is positively related to advertisement expenditure. This is the hypothesis. For that what the background observation we have to take, or what the background, may be the information we have to take. Now, what is hypothesis, as I was telling it is may be a verbal statement about the relationship between two variables.

(Refer Slide Time: 42:55)



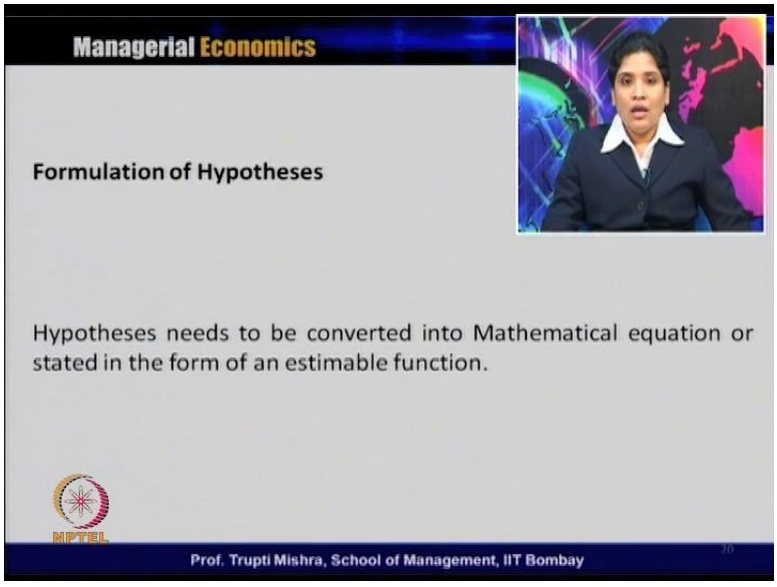
So, it is a postulate, it is an untested proposition we have not yet tested, regarding the relationship between two or more variables in the real-world phenomena. It shows only the probability of the event and serve as a guide for the future action, but cannot predict the result of an action. So, as we are discussing, the outcome is not known over here. It can be always take what be the probability of the event; like in this case if the advertisement expenditure increases, what will happen to the sales. So, the outcome of the event is unknown, only it can predict; that since the both of them they are positively related, when you increase the advertisement expenditure, the possibility is that the sales will also increase. So, this is your hypothesis is a postulate, untested proposition, regarding the relationship between two variables in a real-life phenomenon.

(Refer Slide Time: 43:54)



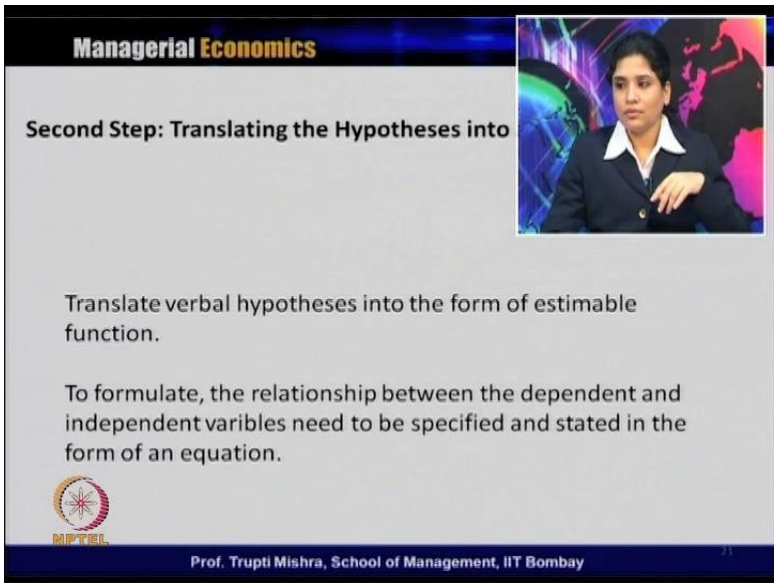
Now, as we are just formulating the hypothesis, suppose you take the hypothesis, sales growth is a positive function of the advertisement expenditure. Now on the basis of that, the hypothesis suggests that, if a firm spends money on advertisement, its sales will most probably increase. Again it is a probability, there is no certainty that if the firm is spending money on the advertisement, the sales has bound to increase. There is a probability that the sales will increase, if the firm is spending money on the advertisement. It does not convey the approximate increase in the sales for a given advertisement expenditure.

(Refer Slide Time: 44:33)



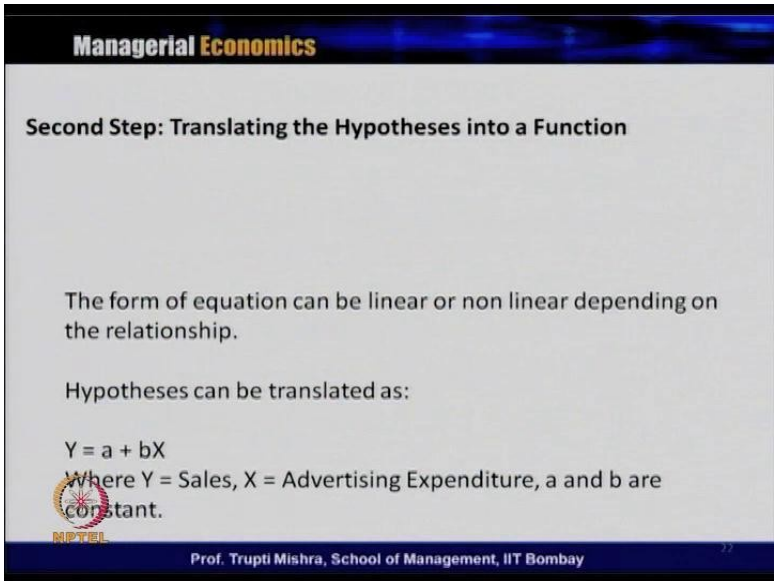
So, hypothesis need to be converted into mathematical equation or stated in the form of an estimable function. Since it is a probability of event, we need to support it through the data, we need to support it through the function, in order to check whether the hypothesis is validated or not, or hypothesis goes true or not, for that we need to convert it to a mathematical equation or convert it in the form of the estimable function.

(Refer Slide Time: 45:04)



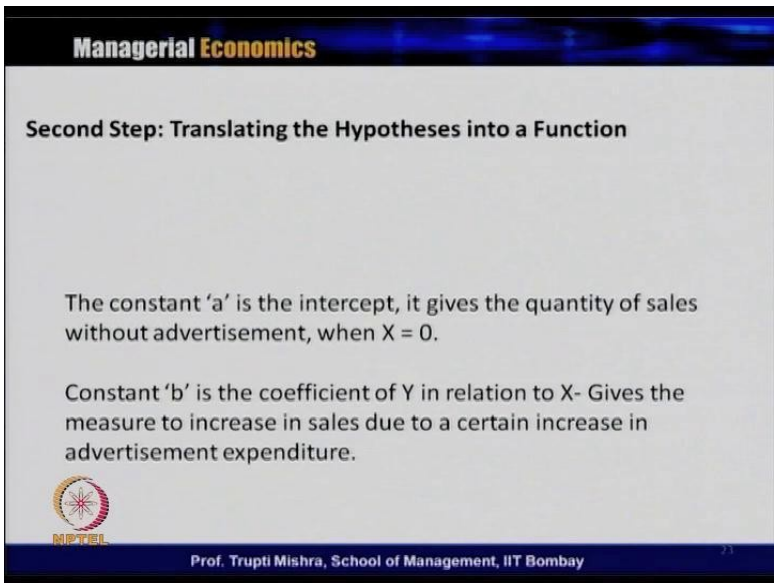
So, there it comes to the second step, and what is the second step. The second step, when you translate the hypothesis into a function. So, it is a hypothesis, as I was mentioning it is a verbal statement on the basis of some observed relationship between two variables. So, in the second step we translate the hypothesis into a function, we translate the verbal hypothesis into the form of a estimable function. And to formulate the relationship, to formulate the verbal hypothesis into a estimable function, we need to identify, what kind of relationship is there, between the dependent and the independent variable. So, the relationship between the dependent variable and the independent variable need to be specified, and it is in the form of an equation. So, the form of equation can be linear, it can be non-linear, depending on the relationship.

(Refer Slide Time: 46:01)



So, hypothesis can be translated, as suppose in this case we take a equation, that is Y is equal to a plus b x, where Y is the sales x is the advertising expenditure, a and b are constant. So, Y is here dependent variable, x is independent variable. So, y is the sales x is the advertising expenditure a and b are the constant.

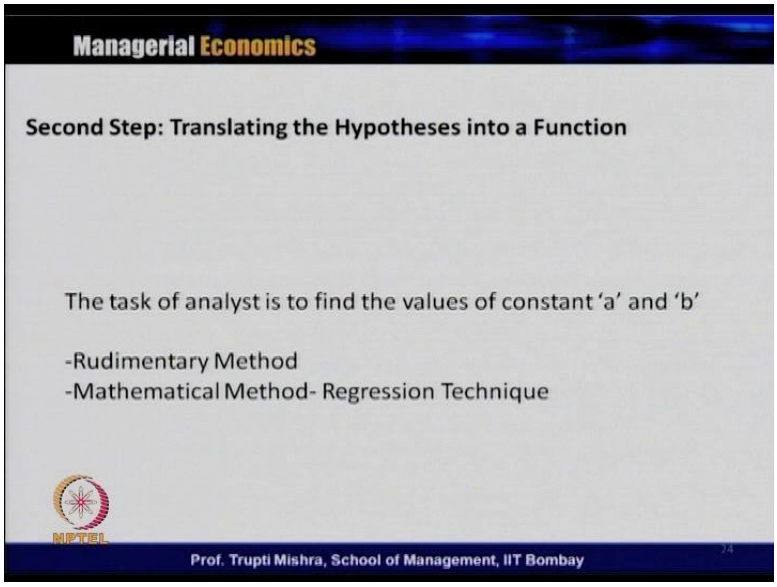
(Refer Slide Time: 46:28)



The constant a over here is the intercept, and it gives the quantity of sales without advertisement when x is equal to 0. So, there are two constant; one is constant a, another is constant b. Constant a is the intercept, it gives the quantity of sales without advertisement

when x is equal to 0, and constant b is the coefficient of y in relation to x, and it gives the measure to increase in sales, due to certain increase in the advertisement expenditure. So, if you look at b is directly related to the value of x. It gives the measure to increase in the sales, due to certain increase in the advertisement expenditure. So, b is the slope, a is the intercept, a gives the quantity of sales without advertisement, when x is equal to 0. And b is the coefficient of y in relation to x, and it gives the measure to increase the sales, due to certain increase in the advertisement expenditure. Now, task of analyst come here, to find out the value of a and b, because a is unknown over here, b is unknown over here, a gives us a value of sales, when there is no advertisement expenditure, and b gives us the value of the slope, which tells us that if advertisement expenditure increases by certain proportion, what is the exact proportion change in the sales.

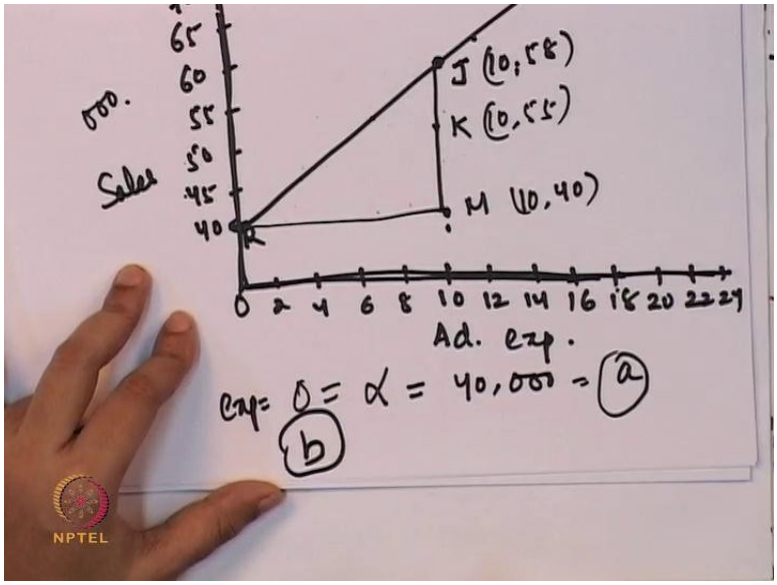
(Refer Slide Time: 48:06)



So, the task of analyst is to find out, what is the value of a, and what is the value of b. There are two methods to find out the value of a and b; one is the rudimentary method or the elementary method, and the second one is the mathematical method or the regression technique. So, we will see through using the elementary method or using the rudimentary method, how to fund the value of a and b, and then again we will see the mathematical method or the regression technique, using that how to find the value of a and b. So, using in order to find the value of a and b, through the elementary method, we will use again the same data of the, what we are taking from the managerial problem, that is in the form of what we

present in the form of the scatter diagram, and then we will find the value of a and b over there.

(Refer Slide Time: 48:50)



So, what we take in the y axis, and what we take in the x axis; x axis we take the advertisement expenditure, and y axis we takes the sales. So, this is 2 4 6 8 10 12 14 16 18 20 22 or 24. And here we take, may be 40 45 50 55 60 65 70 75 80 and 85 and 90. So, since we have, suppose the value of may be intercept it starts from here and we take a regression line. Suppose this is R and suppose this is L. So, if you take this may be R is 1 and L is the other combination, maybe there are different combination here of the advertisement expenditure and the sales. Suppose, we get a combination; that is, 10 and 58, so this goes to here, where your, suppose this point, this is point J, where it is 10 and 58. Or may be below somewhere that we get a combination K, which is again 10 and 55, or maybe we get a combination M, where it is, maybe it is somehow between 40. So, this is combination M, where we get 10 and 40.

Now, if you remember just now we discussed that the value of the intercept. So, if you look at, when the zero expenditure on advertisement expenditure, the total sales is 40. When the advertising expenditure is 10, maybe we have different combination where 10 is equal to, 10 is advertisement expenditure and 40 is the sales, K is the advertisement expenditure, 55 is the sale, and at the point J 10 is the advertisement expenditure and 58 is the sale. So, when it is equal to zero, we get the value of intercept; that is, alpha which is equal to 40,000, if you are taking this in the zero unit. Now, what is the next task? Next task is to find out the slope of

this, because this is the value of a. When expenditure is equal to 0, alpha is, value of intercept and this is the value of a. Now, second what we have to find out through the rudimentary method or through the elementary method, we need to find the value of b.