Managerial Economics

Prof. Trupti Mishra

S.J.M. School of Management

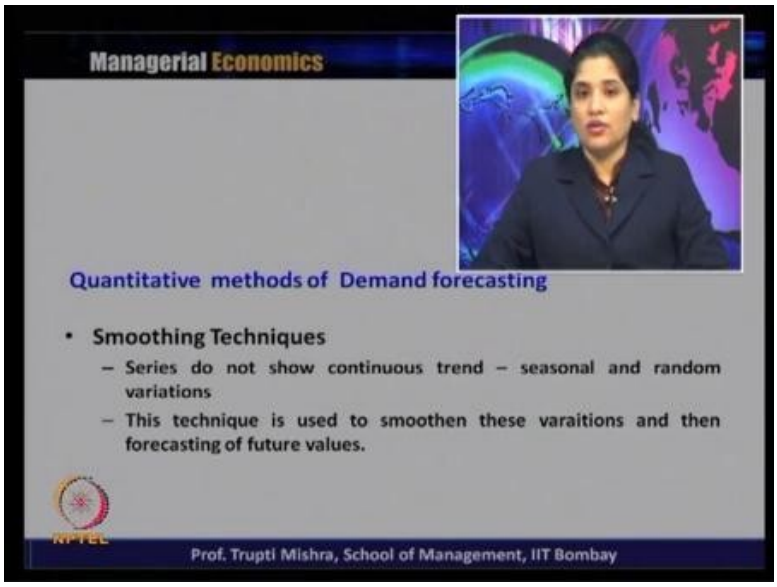
Indian Institute of Technology, Bombay

Lecture - 32

Demand Forecasting (Contd…) - II

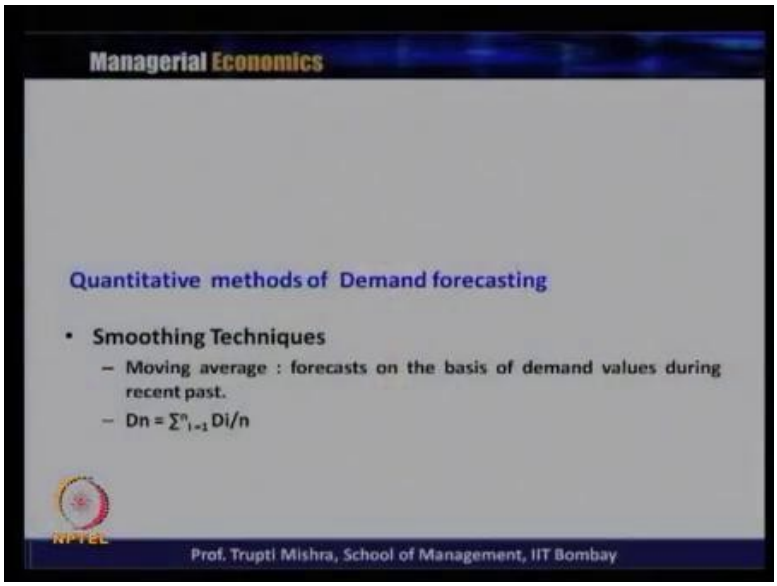
Then, we will come to the smoothing technique. Why the smoothing technique is required?

(Refer Slide Time: 24:41)



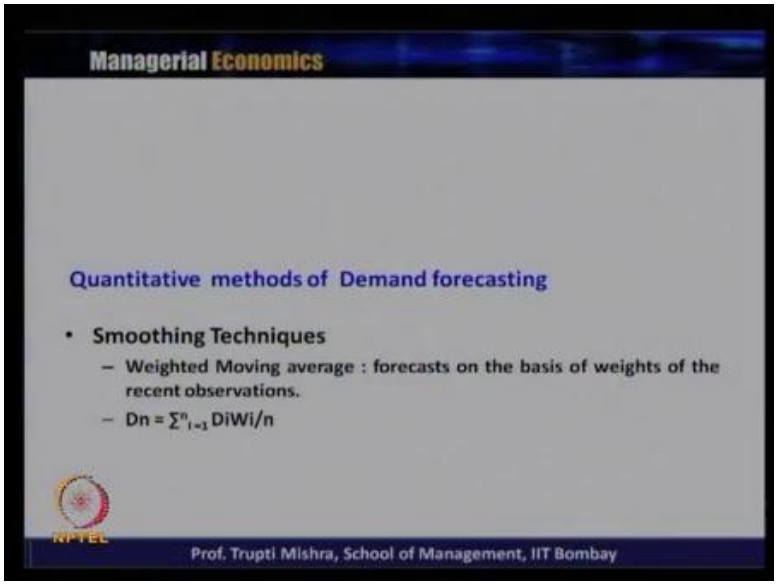
The series do not show continuous trend. There may be seasonal and the random variations. As we discussed, there may be the secular trend, the seasonal trend, the cyclical trend, there may be the random variations. So, series do not show continuous trend, either there is seasonal or there is may be random variation. Generally, this smoothing technique is used to smoothing this variation and forecasting the future value since there is variation the smoothing technique is being used to smoothen the series. On that basis, the future value can be forecasted. Then, we will see what are the smoothing techniques. So, smoothing is generally used to smooth used to smooth the variation in the series, variation in the time series data, so that there will be more accuracy in the future forecasted demand.

(Refer Slide Time: 25:39)



So, there are 3 methods of smoothing technique. The first one is moving average and in the moving average method, it forecasts on the basis of the demand values during the recent past. So, here, if you take D is the demand, the time period n, in this take, we take the D n. That is the sum total of the demand D i divided by the number of observations n. So, in this case, moving average, the forecast is based on the demand value in the recent past. Here, the if you look at i stands, takes the value from 1 to n. Here, it is the simplest version of the smoothing technique. But, here we take the basis of the demand value only from the recent past.

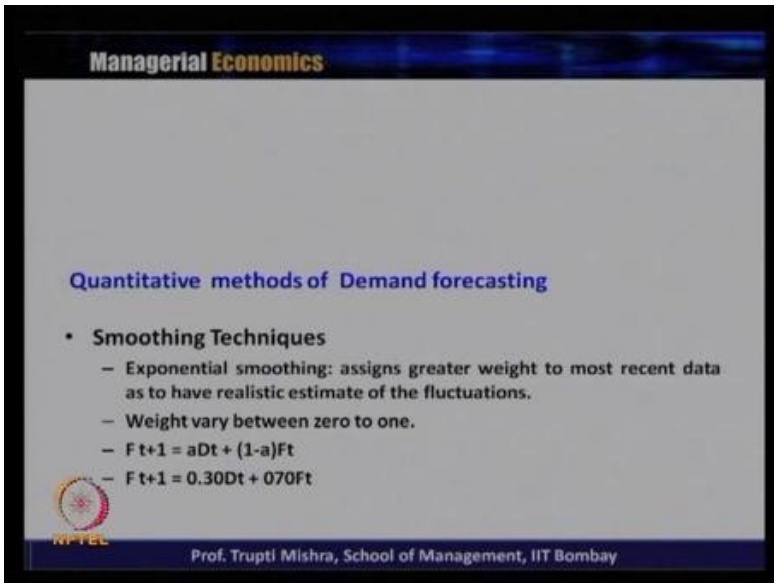
(Refer Slide Time: 26:31)



Then the second technique is the weighted moving average is the forecast on the bases of the weights of the recent observations. So, here if you at the demand is in the basis also not only the demand in the previous time period, also whatever the weight to this demand in the previous time period, whatever the weight of the specific variable.

That also is taken into consideration in case of weighted moving average. So, weighted moving average is not only the not dependent only on the past demand rather also that whatever the weight assigned to them. Those variables, it is also taken care in case of the weighted moving average. Then, the third method is exponential smoothing.

(Refer Slide Time: 27:13)



In case of exponential smoothing, generally, it assigns a greater weight to most recent data to have a realistic estimate on the fluctuations. So, this is again more improved, more revised in form of whatever the weighted smoothing technique. In this case, it generally assigns, this technique generally assigns a greater weight to most recent data as to have a realistic estimate of the fluctuation rather.

If it is a time series data of 10 years, most importance is given to the past year, past 2 years, past one year rather than the similar weight across the year from all these 10 years. In this case, the weight is given more to the specific year, which is just before this present period. So, here the weight varies between 0 and 1, if it is 10 years. If the forecaster feels that 10 years is not going to that much relevant, may be they can assign 0 weights to the 10 years

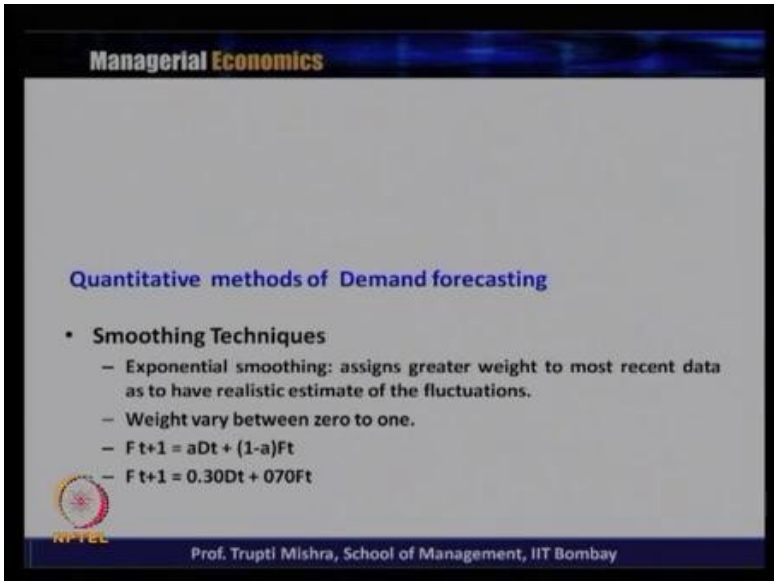
data; may be again, the numbering starts from 9. May be the less weight to the 9 little bit, more to the 8.

Similarly, if it is to the time period 1, the time period 1, more assignment will be given. The weight will be assigned to year 2 so here if it is in the forecast in for the next time period that is t plus 1. So, the functional form takes form a D t plus 1 minus a F t. So, here if you look at the demand is more dependent on that whatever the forcast value of this present time period because here we are forecasting for the next time period.

What is past period for next time period? Here, it is present time. So, if we are doing this for the t plus 1 time period, more weight will be assigned to time period t rather than any other time period because the past year, the measured weight or the more weight is given to the past year data. So, F t plus 1 is 0.30. So, you take the example that F t plus 1 is 0.30.

Here, it is. We are considering 0.70 as the forecasted demand for the present time period. So, here if you look at this forecast demand for t plus 1, more comes from the 0.7. So, 70 percent comes from the forecasted demand from this present time period and 0.3 for the demand for the rest of the period.

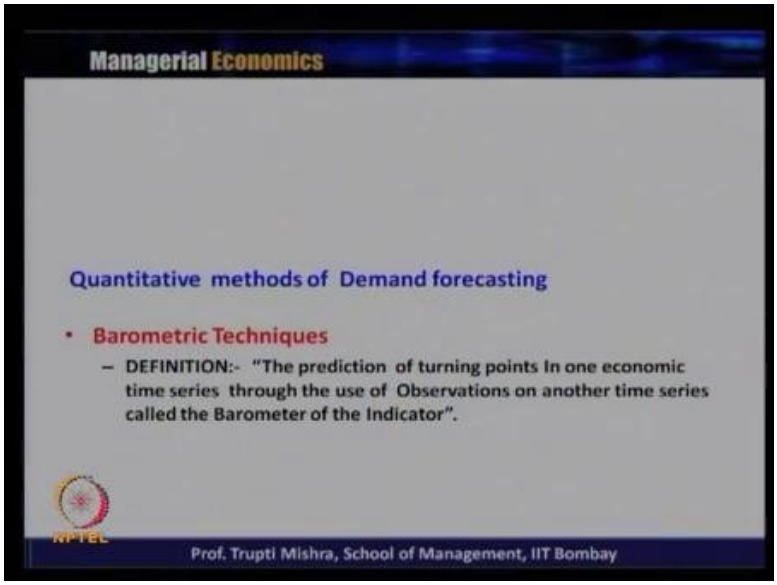
(Refer Slide Time: 29:47)



So, F t plus 1 is equal to 0.30 plus 0.30 F t. In this case for the future forecasting of demand, for the next time period, for the present time period it is t. For the next time period is the future forecasting is for t plus 1 time period. 70 percentage weightage will be given for the

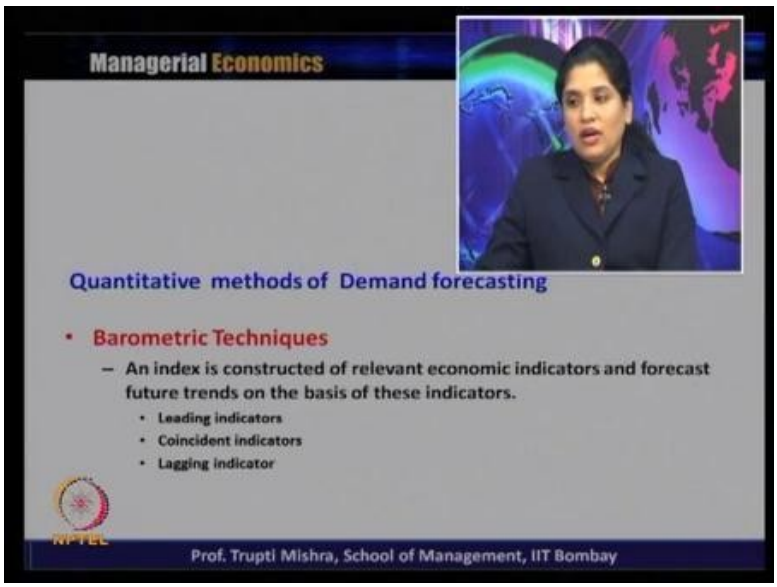
time period t and the rest 30 percent will be given to the demand for the rest of the time period. Then, we will talk about the second method under the quantitative methods that is barometric technique.

(Refer Slide Time: 30:27)



What is barometric technique? Barometric technique is, to define it, it is the prediction of the turning points in one economic time series to the use of observations on another time series called barometer of the indicator. Generally, barometer is one who records this activity or generally we crystallize all fluctuations in the economic activity.

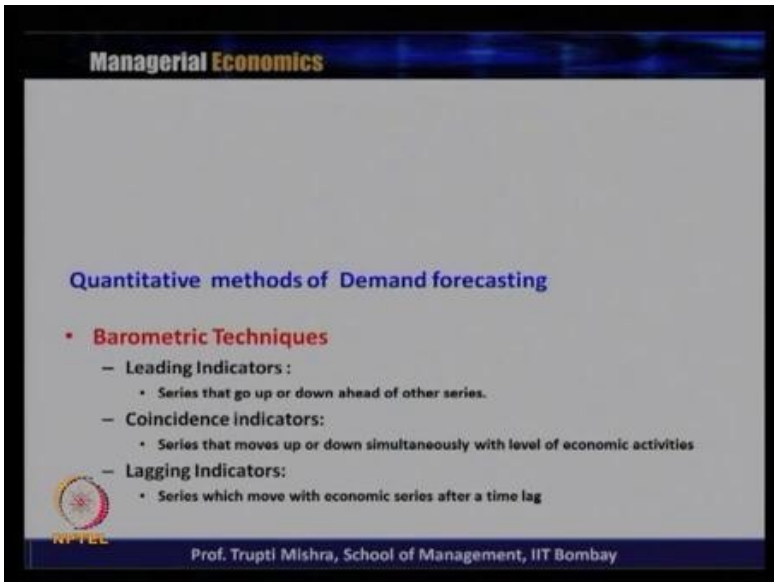
(Refer Slide Time: 30:54)



So, in the barometric technique, generally an index is first constructed on the relevant economic indicators and forecast future trend from the basis of these indicators. So, what, how this barometric technique is being practiced? Index will be constructed and what will be component of the index? The component of the index will be the relevant economic indicator.

Once the index is constructed, on that basis future trend will be forecasted on the basis of this indicator. Now, what are the indicators in this case taken for the construction of the index? We take 3 types of indicators. one is the leading indicator. The second one is the coincident indicator. The third one is the lagging indicator. What is a leading indicator?

(Refer Slide Time: 31:42)



A leading indicator is one where the series that goes up or down ahead of the other series. So, if the one series is about price quantity and the other is about the income quantity, in this case of the price quantity series is always going up the income quantity series. We can say that the price quantity, they are the leading indicators compared to the income and quantity. So, leading indicator is one where the series always goes up or down ahead of the other series.

Then, we have a coincidence indicator. What is a coincidence indicator? this is typically a series that moves up or down simulteniously with level of economic activities. Whatever the series, simultaneously it moves up or down. So, in a specific time period, it moves in a specific time period. It comes down. So, moving up and coming down, it will follow a

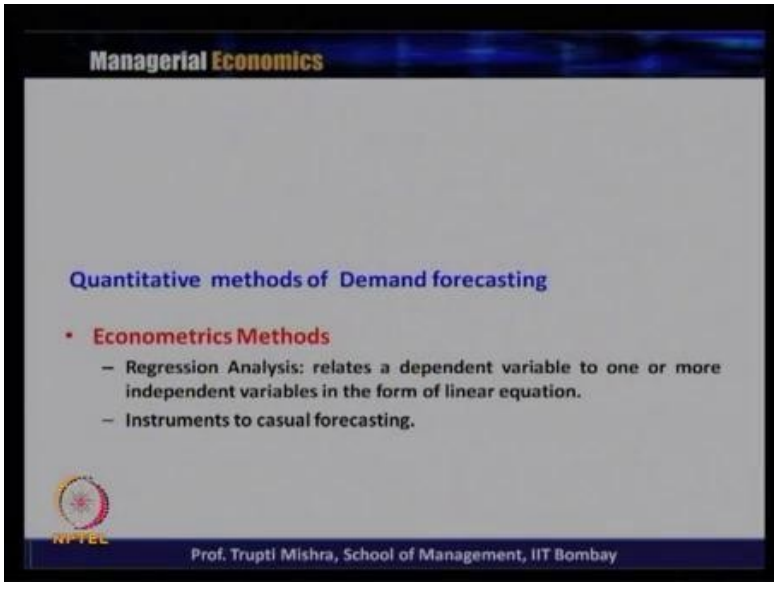
regular trend and that is why it is called as the coincidence indicator. because the series, it moves up with the increase in the economic activity, down with the decrease in the economic activity.

The third type of indicators is lagging indicator. Lagging indicator is an indicator, which moves with the economic series after a time lag. So, if the economic is, economy is going through a boom in period t, this indicator will move in the t plus 1 period. It will not move in the t period because it is a lagging indicator.

If economic activity is more in time period t, this indicator will be moving up in time period t plus 1. That is why this lagging indicator is known as the series, which move with economic series after a lag of the time period.

So, first we had the trend projection method. Then, we had the barometric method in the quantitative methods. Then, the third method is the econometrics method. What is econometric method here?

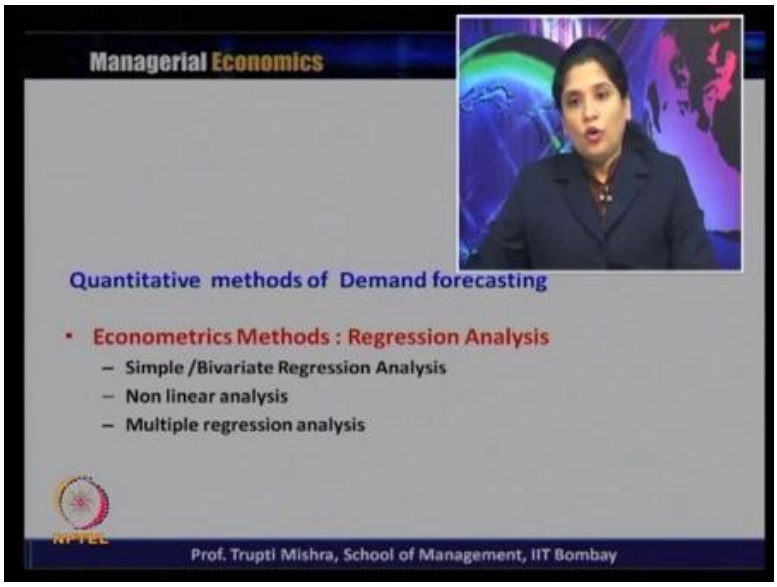
(Refer Slide Time: 33:51)



We take two kinds of analysis, one is the regression analysis and the second is the simultaneous equation method. Regression analysis generally relates the dependent variable to one or more independent variables in the form of a linear equation. As we discussed, when we were discussing about the regression analysis, so correlation talks about the relationship between 2 variables, whether they are positively related, whether they are negatively related.

Regression talks about that what is the extent of the relation, in which direction or what is the magnitude of change in 1 variable when the other variable changes? How they are related? That we generally do in the regression analysis. So, generally, the regression analysis relates the dependent variable into the independent variable in the form of a linear equation. This is instruments to the casual forecasting. Now, we will see how this regression analysis is generally useful in the forecasting method.

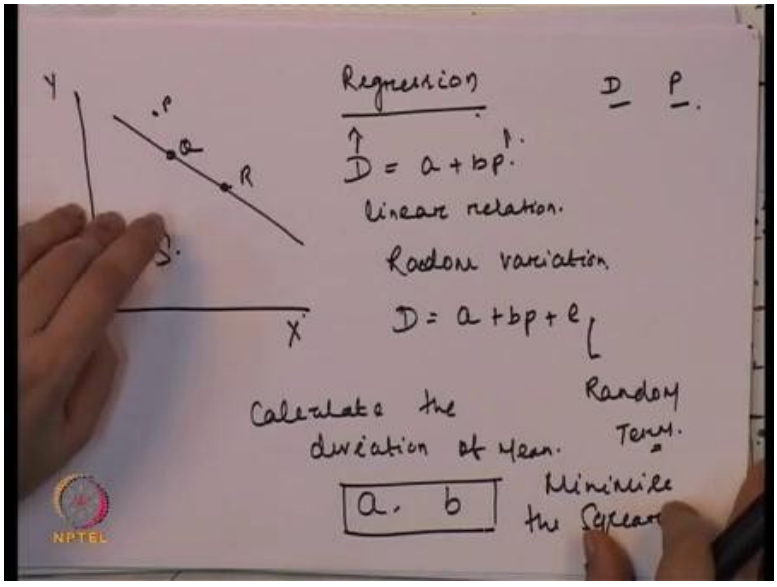
(Refer Slide Time: 34:53)



So, before that, we will see that there are 3 types of regression analysis. One is simple or bivariate regression analysis, where it is basically the relationship between 2 variables, 1 dependent variable and 1 independent variable. They are linearly related in case of 2 variable regressions. Also, they are not related linear way rather they are related in a non-linear way. We get a non-linear regression analysis. When we study the relationship between 1 dependent variable and number of independent variables, we get the multiple regression analysis.

The simple regression analysis is the relationship between 1 dependent and 1 independent variable, non-linear relationship when the variables are related in a non-linear way and multiple regression analysis where the 1 dependent variable is dependent with number of independent variables. This kind is when the functional form or this kind of equation that is generally the multiple regression analysis. Next, we will see how this regression is used for forecasting methods.

(Refer Slide Time: 36:12)



So, if you are taking a simple analysis, of simple regression analysis example of simple regression analysis is suppose that D is equal to a plus b p. Here, we say that both the variables they are linearly related. There is a linear relation between D and p. So, D is the dependent variable, p is the independent variable.

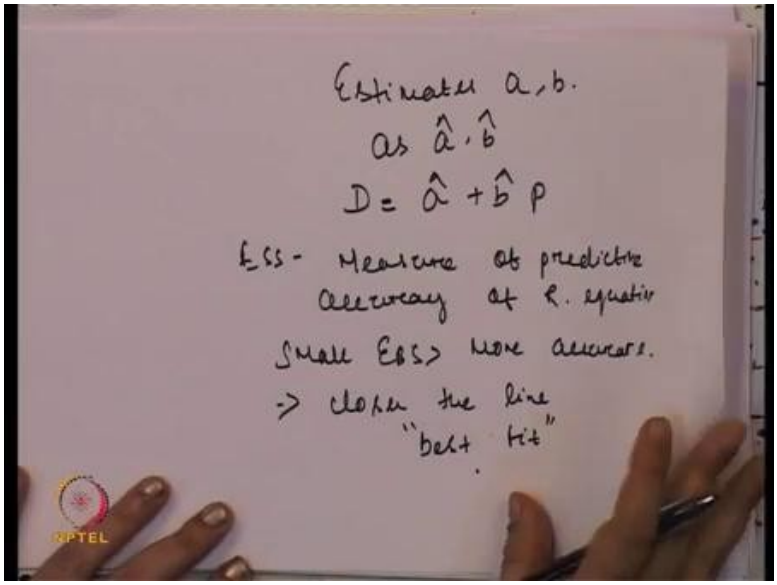
Now, if you plot it, we have different series of the values for D and p. We will get the combination here. and if you plot in the graph, maybe we will get combination, one combination is P, another combination is Q, another combination is R and another combination is S. So, when p takes a value, what is value of D? When p takes a different value, what is the value of D? on that basis, we get all this point. So, this point talks about that how both of them are related. Now, here of you look at this is the regression line. If they are, if this is, if the combination between d and p, if this line we feel that they are the line of best fit because they are lying on the regression line. But, there may be some random variation. If you incorporate such variable, why there is a random variation? because here, if you look at Q and R, they are lying on the regression line, where as p is lying above the regression line. S is lying below the regression line. Q and R are in the line. So, when we consider that, there is a random variation. Now, how this regression equation will be this will

be a plus b p plus e because e is the random term related with the variation related with the random variation.

Now, to minimize this random term, we need to calculate the deviation from mean or we need to calculate what is the distance of all these points from the regression line. For that, we need to find the values of a and b. How this value of a and b will be used? The value of a and b will be used to minimize the, minimize the square deviation; square deviation between the line and the actual data point.

Because basically Here, we are trying to here; we are trying to manage that whatever the deviation on the regression line and on the points on the actual points that we need to generally minimize. To minimize this, we need to find the value of a and b and through the value of a and b, we can minimize the square deviation, the sum of square deviation between the line and the actual data point. So, once we get this value of a and b, that is going to give us, that will help us to minimize the difference between the actual data point, actual data point and the regression.

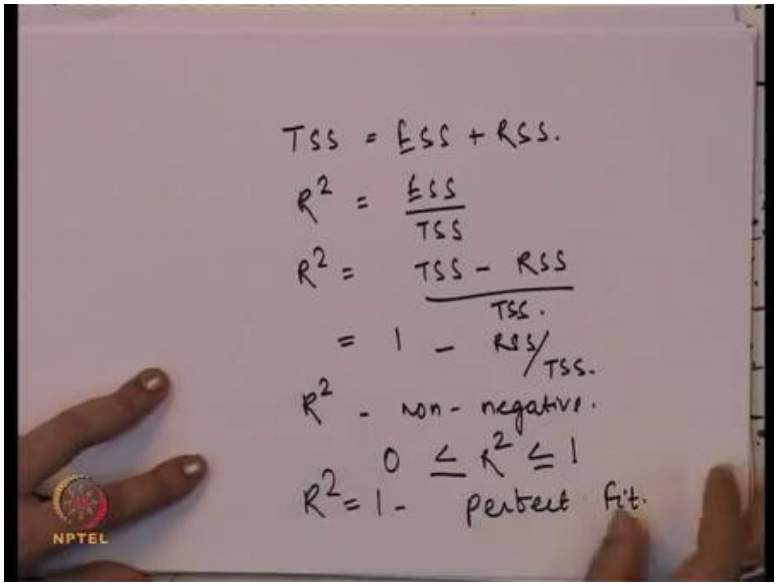
(Refer Slide Time: 39:45)



Then, we get the estimates of a and b in that point. So, once we get the estimates of a and b, this is as a cap and b cap. The new regression line will be a cap plus b cap p. Here, we sat that these values of a and b take care of the of the deviation from the regression line and the actual point.

Here, we get the time term that is explain sum of square. This is the major of the predictive accuracy of regression equation. So, if it is smaller ESS, if the value of this is small, then more accurate and if it is closer the line, then this is the best fit because the deviation between actual point and the regression line is actual point and, the regression line is minimal.

(Refer Slide Time: 41:08)



Now, we find out the the coefficient of determination to find out that these 2 variables how they are related? So, to find this, we need to find the total sum of square. Total sum of square is the expected sum of square plus the residual sum of square. So, R square is expected sum of square and total sum of square. We can just reframe it as TSS minus RSS divided by TSS.

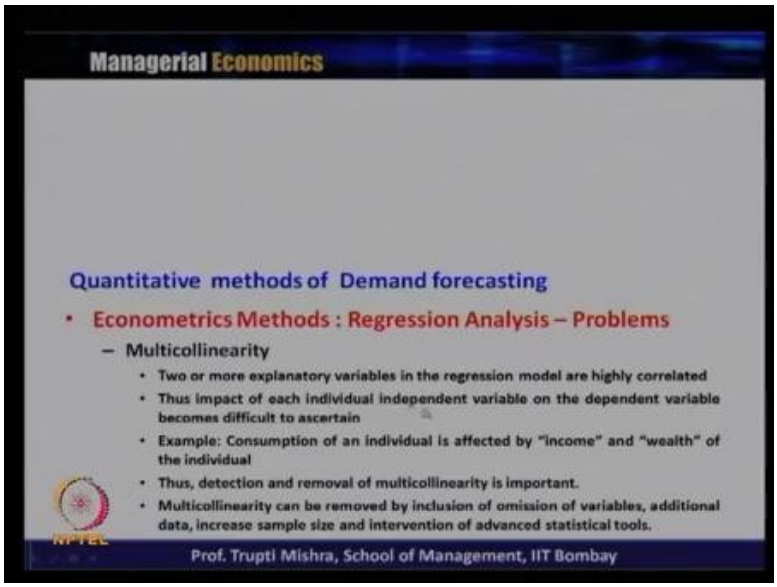
So, this is 1 minus RSS by TSS. If R square is, R square has to be non-negative because it talks about the coefficient of determination like what is the exponentary power of this module altogether.

Then, this should be always 0, R square less than equal to 1. If R square is equal to 1, we call it a perfect fit. Now, how this regression equation can be used for forecasting the demand? So, till this time what we have seen in the regression equation that we are trying to make minimize the error. So, once we get the best fit regression line, on that basis of that, we can forecast these are the actual data points, which is also best fit because there is accuracy in the projected and the plotted.

Once we get that regression line, the best fit regression line on that basis, we can forecast the future demand. Then, what is, what are the problems in these econometric methods?

Specifically, in case of the regression analysis, we can find the value of a and b. On that basis, we can forecast the demand. Also to minimize the error, we can also find out the value of a cap and b cap because that also take care of the minimization of the error between the regression line in the actual data points. We can forecast the demand. But, what are the problems or what are the challenges that are being faced, when we use the regression method to forecast the demand?

(Refer Slide Time: 43:10)



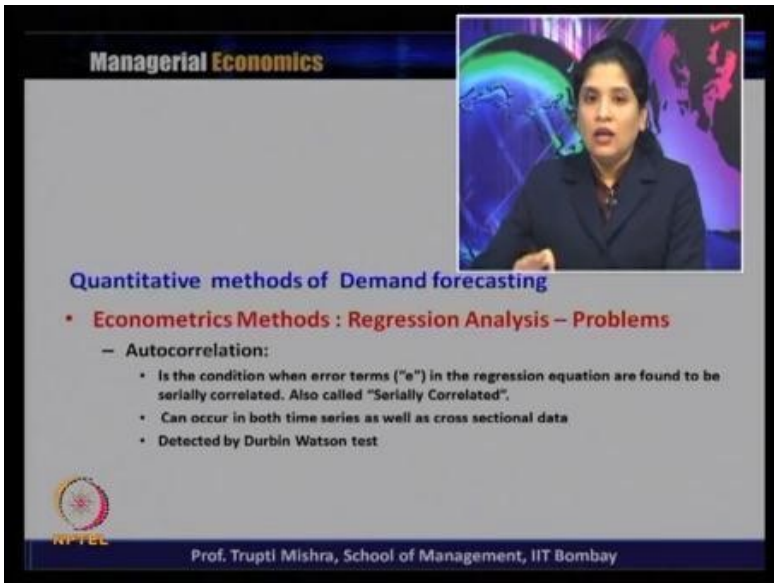
The first problem is multicollinearity. Here, two or more explanatory variables in the regression model are highly correlated. That is why; we call it a multicollinearity problem. Since, they are highly correlated, the impact of each individual independent variable on the dependent variable becomes difficult to ascertain. So, they are correlated. So, what is the impact of independent variable, individual independent variable on the dependent variable?

Finding that is difficult. So, consumption of an individual is affected by the income and wealth of the individual. If you look at income and wealth, they are closely related. So, in this case, the detection of removal of multicollinearity is important because otherwise it is

difficult to find out what the contribution to consumption from the income is and what the contribution to the consumption on the wealth of the individual.

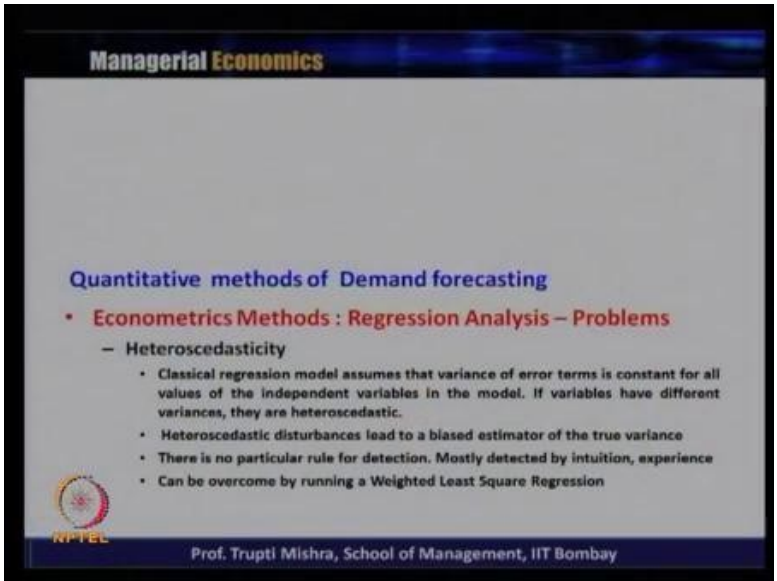
So this multicollinearity can be removed by inclusion of omission of variables, additional data, increase the sample size and the intervention of the advanced statistical tools.

(Refer Slide Time: 44:17)



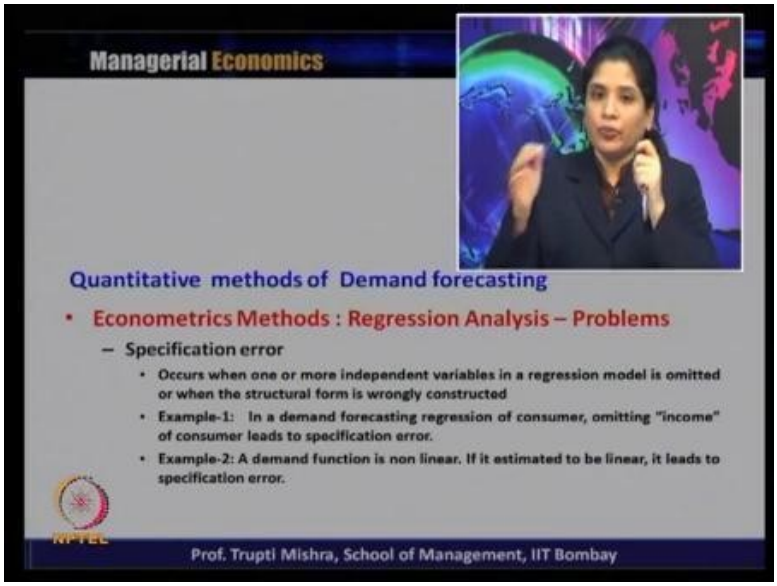
The second point is autocorrelation. When we get this condition of this autocorrelation, this is the condition error terms e in the regression equation are found to be serially correlated or also called as serially correlated rather than autocorrelation. It can occur both in time series as well as cross-sectional data, and to correct this autocorrelation problem, generally we use the Durbin Watson test to see the error terms that at least not serially correlated. Then, the third problem is of heteroscedasticity.

(Refer Slide Time: 44:54)



What is the problem of heteroscedasticity? Because the regression model always assumes that the variance of the error term is constant for all the values of the independent variable in the model. But, if the variables have different variances, then we generally land into the heteroscedasticity situation. This disturbance leads to biased estimator of the true variance. There is no particular rule for detection for heteroscedasticity.

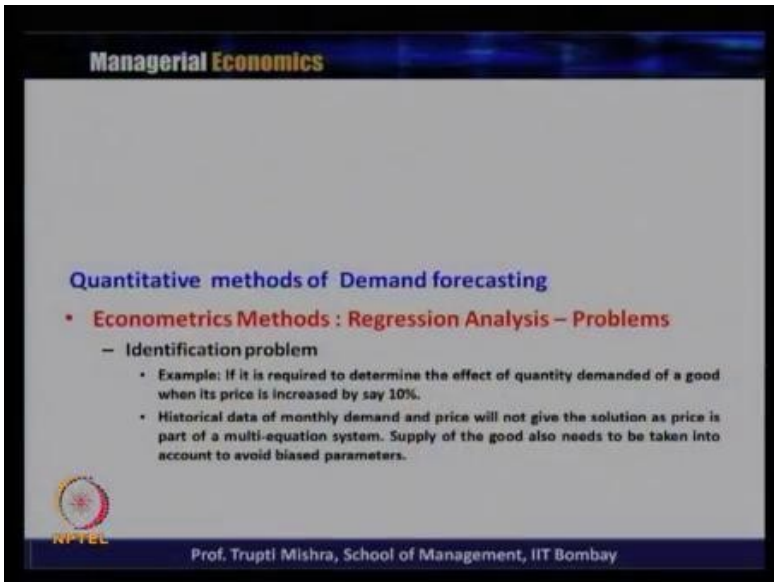
(Refer Slide Time: 45:40)



Mostly, it is detected by the experience. It can also can be overcome by the running a weighted least square regression like giving a weight to each of these variables or may be through the smoothing technique. This weighted average mean of the weighted least square can be used to solve this problem of heteroscedasticity. Then if we have specification error it occurs when one or more independent variables in the regression model is omitted. When the structural form is wrongly constructed.

So, we take an example like in and demand forecasting, regression of consumer, omitting income of consumer leads to specification error. Example 2 is the demand function is non-linear. But, the estimate to be linear leads to specification error. Then, identification problem.

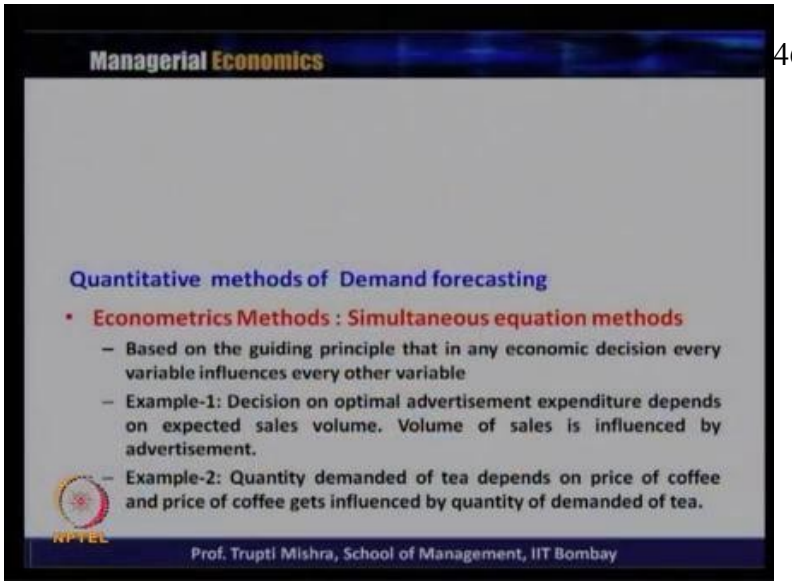
(Refer Slide Time: 46:19)



Typically, this is the typical example taken in case of identification problem. If it is required to determine the effect of the quantity demanded of a good when the price is says increased by 10 percent. Historical data of monthly demand and price will not give the solution as price is a part of the multi-equation system. The supply of the good also needs to be taken into account to avoid the biased parameters.

So, there is also problem of identification in case of the regression. So, the second method or the second method of the econometric is come as the simultaneous equation method.

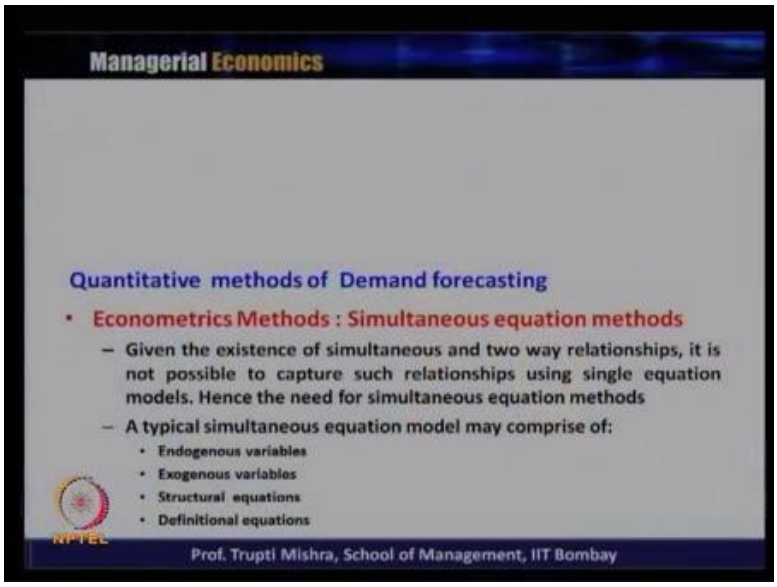
(Refer Slide Time: 46:49)



What is generally used to forecast the demand? Now, what is this simultaneous equation method? Based on the guiding principle that in any economic decision every variable will influence every other variable, so in any economic decision, all the economic variable influences every other variable. Like you take the example of decision on optimal advertisement expenditure depends on expected sales volume. Volume of sales is also influenced by the advertisement.

Example 2, quantity demanded of the tea depends on the price of coffee and also price of coffee get influenced by the quantity demanded for tea. So, if you look at the variables, they are related to each other. That is why; all the variables influence the other variables, every other variable when it comes to economic decision. So, since there is a simultaneous and two way relationships between these 2 variables.

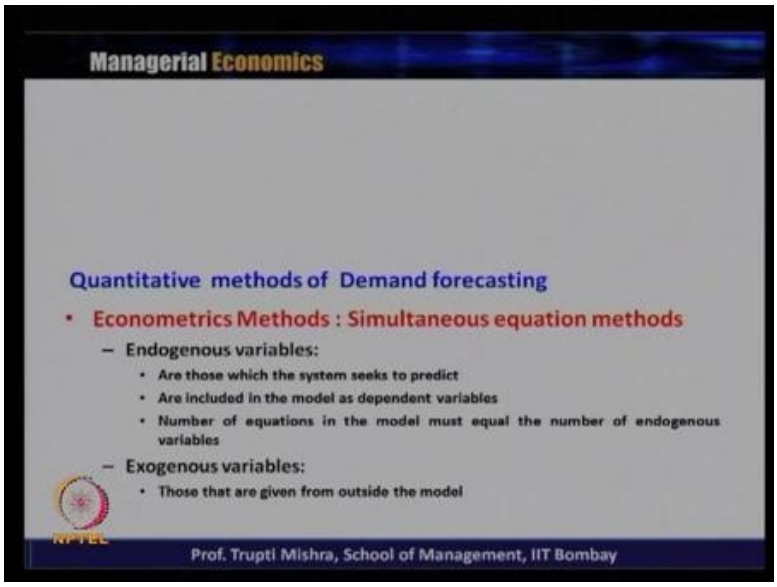
(Refer Slide Time: 47:51)



The variables, which influence for or which require to forecast the demand, if it is not possible to capture such relationship using single equation models, like a typical regression model. Hence, the need of simultaneous equation method comes from here. A typical

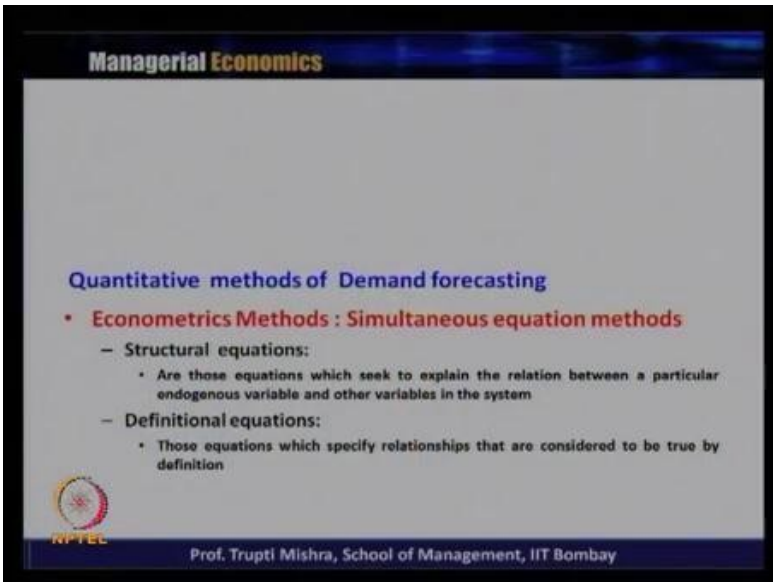
simultaneous equation method comprises of endogenous, exogenous, structural equation and definitional equation.

(Refer Slide Time: 48:10)



What is endogenous variable? Endogenous variable are those, which the system seeks to predict. They are included in the model as dependent variables. The number of equations in the model must equal to the number of endogenous variables. Exogenous, those are given from outside the model. It is not in if you look at the number of equations, it is not dependent on the exogenous variable. Then, we have structural equations.

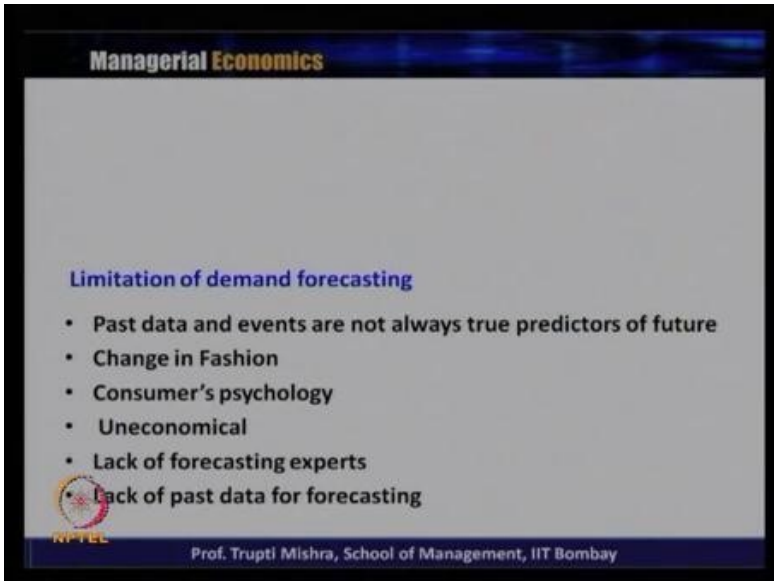
(Refer Slide Time: 48:42)



Structural equations are those equations which seek to explain the relationship between a particular endogenous variable and the other variables in the system. Definitional equations are those equations that specify the relationships that are considered to be true by definition.

So, through these four components generally, the simultaneous equation method is used so that the different description of this method is not within the scope of this typical course of this typical session. So, that is why we have just identified this model that how this model is being used to forecast the demand. Now, what are the limitations for this demand forecasting because in the previous classes, we talked about the subjective methods of demand forecasting? In this class, we talked about the quantitative method of demand forecasting. As a whole, there are few limitations of the demand forecasting. What are those limitations?

(Refer Slide Time: 49:37)

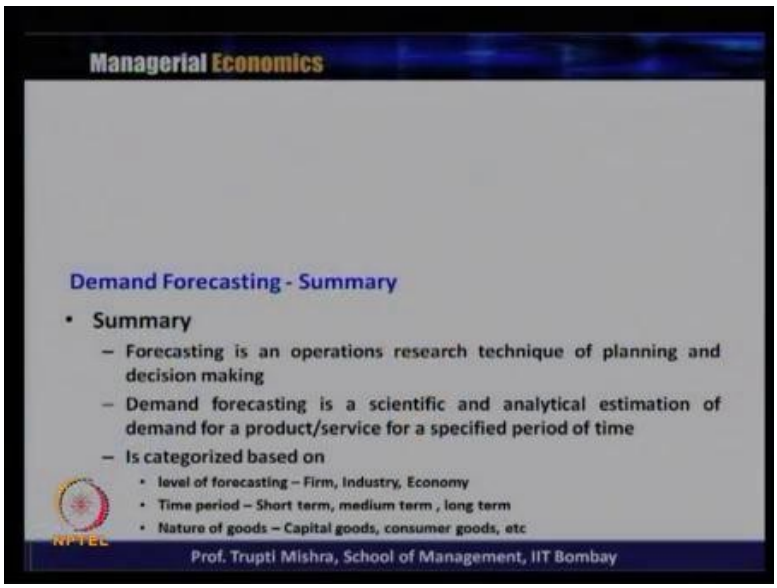


Past data and events are not always the true predictors of future because whatever the events that may not recur in the future time period. Also, about the trend, that also may not occur because as a whole, if you look at the time period, it is dynamic for the previous time period. The next time period may not happen in the same way. If there is a change in the fashion again, the forecasting will be difficult because again, if we are doing a forecasting for the next 5 years, may be the fashion has changed.

The people may not be going to buy the same products. That is why it is difficult to do the forecasting for the product consumer psychology changes with the time. So, again there is a difficulty in capturing the consumer psychology. On that basis, doing the demand forecasting is costly because it is an exhaustive process to do the forecasting.

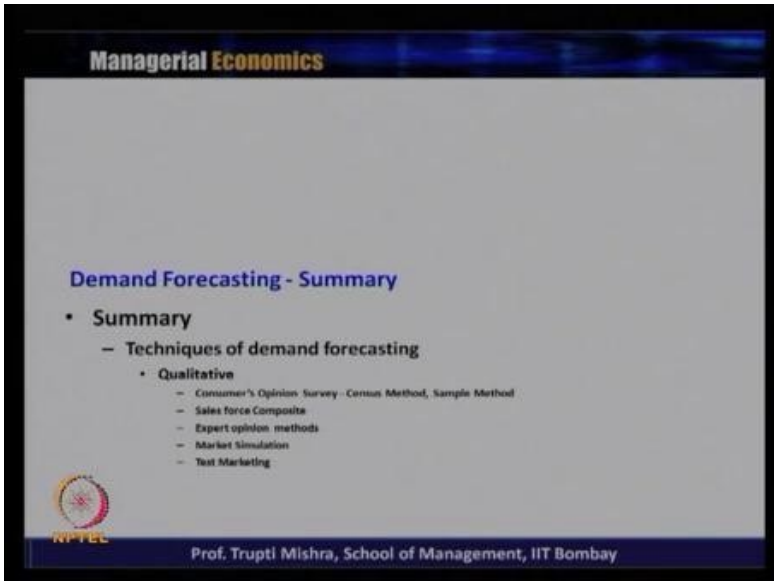
When there is, if you look, there is a lack of forecasting effort. There is also a lack of past data for forecasting. which creates another challenge for demand forecasting, especially for the economic organization.

(Refer Slide Time: 50:55)



So, whatever we discussed in the previous session about demand forecasting and in today's session about demand forecasting to summarize, we can say that forecasting is an operations research technique for planning and decision making. It is a scientific and analytical estimation for demand of product or service for a specified period of time. This is categorized on the basis of the level of forecasting, on the basis of time period, on the basis of the nature of goods. We have 2 techniques of demand forecasting.

(Refer Slide Time: 51:14)



They are qualitative, where we consider the consumer's opinion survey, sales force composite, expert opinion methods, market simulation and test marketing. We have quantitative, where we discussed about the trend projection smoothing technique, barometric method and also the econometric method. So, these are the techniques. Also, we discussed about some challenges about the demand forecasting for the particularly when the time is dynamic, the consumer psychology changes.

Also, there is a difficulty in getting a good forecast expert. It depends on whatever the past data that is also and the non-availability of that also is challenge for the demand forecasting. Nevertheless, the demand forecasting always helps the firms to plan their output, plan their distribution plan, their procurement of raw materials. But, still there are few challenges to face, if the demand forecasting has to be done.