Managerial Economics
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Lecture - 16
Demand Forecasting (Contd…)

So, in today's session, we will continue our discussion on demand forecasting. So, if you remember, in the previous class, we talked about that what is the need for demand forecasting, what are the different techniques of demand forecasting, the different steps involved in that. Then, we talked about the methods or the techniques of demand forecasting, typically more on the subjective part of it. Generally, that is known as the subjective or the qualitative methods of demand forecasting. In today's class, we discuss about the quantitative method of demand forecasting.

So, to start with why we need this quantitative method for demand forecasting, if you look at subjective methods can be used only when past data is not available.

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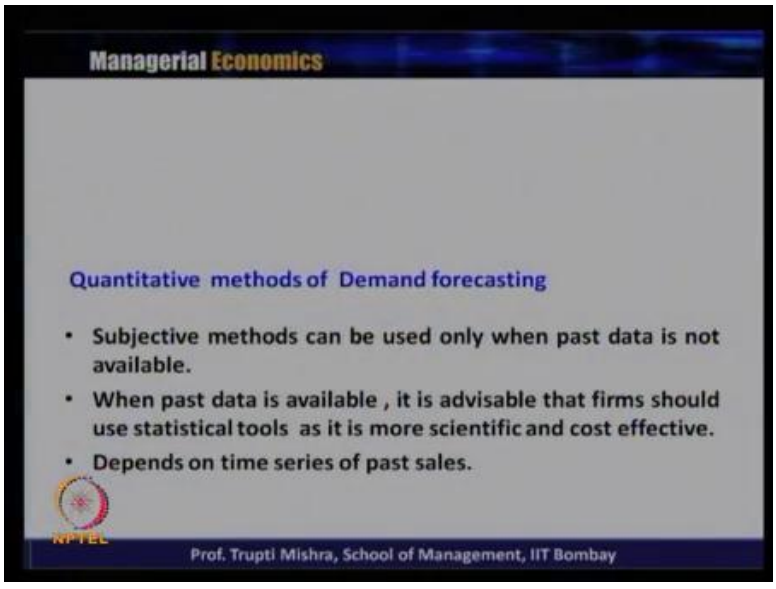

When the past data is available, it is advisable that the firms should use statistical tools as it is more scientific and cost effective. So, if you remember, the case of when we are discussing the subjective method, we also discussed that is subjective method is generally used if it is a case of a new product getting into a new market or doing some improvement in the market or getting into a specific segment of the market.

So, in this case, the subjective method is generally more valid because here, there is no past data is available. But, when the past data is available, it is also advisable to get more scientific, more accurate demand forecasting and also more cost effective demand forecasting. it is better to use the statistical tools, so that on the basis of the past data, you can use the statistical tools and you can get more effective for the accurate demand forecasting.

Generally, in this case, the quantitative method, it is more depend up on that whatever the past data available; about the quality and quantity about the past data. That gives more clarity about the accuracy of the demand forecasting. So, when it comes to the quantitative method of demand forecasting essentially, it depends up on the time series of past sales.

So, to discuss about this quantitative method of forecasting, we will first take the trend methods and in trend method, the trend projection.

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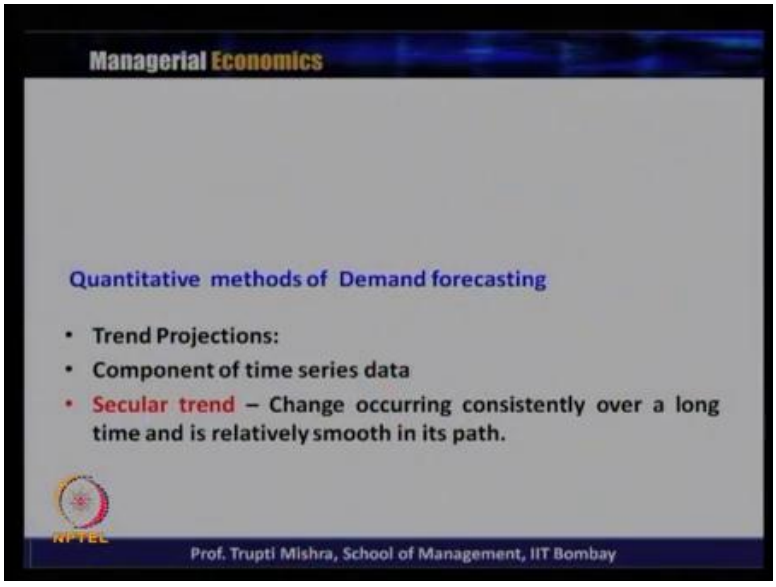

Here, basically we use the time series data. What is time series data? Time series data, when we keep the, when we record the information on a chronological basis, may be it is on a weekly basis, on a monthly basis, on a day basis, on a quarterly basis, hour basis or the yearly basis, when we order this, when we arrange this data on a chronological order, on the, with basis. The basis may be weekly, monthly, yearly or may be in an hour basis or the day basis.

Generally, that is more or less the time series data. This trend projection data, this method typically looking at the past data whatever the trends is being there in the past data, using this quantity method, this typically this trend projection, the projection will be done on the basis of the past trend of that typical data.

So, here the basis for the trend projection is the time series data because time series data gives the trend because it is on a chronological order. We get the full set of data. It gives a trend that whatever the behavior of that typical variable in the past time period. After getting past sales data, the projection will be done in case of the future time period. The projection will be done, what will be the demand for that product in the future time period. So, in case of time series data, mainly there are 4 components.

First one is secular trend. In case of secular trend, generally, the change occurs consistently over an over a long time. It is relatively smooth in its path. So, we know that in case of secular trend means it is equal. If you look at it, it is a trend, whatever change in the trend. Suppose, it may happen that in the time series data, if you have 5 years data, the trend is that may be every year in a particular month, increases or every year in a particular month, it decreases or may be in the beginning quarter, it increases and in the end quarter, it decreases.

So, the demand whatever changes in the demand, which remains same in case of the secular trend. This change occurs consistently over a long time. It is not that it just changes for 1 year. The next year it is not changing or the third year it is not changing, rather whatever is the change, and it goes on for a long period of time. That is why this is known as the secular trend. In case of secular trend, the change occurs consistently over a long period of time and relatively smooth in its path. Why it is smooth because it is consistent and it occurs for a long period of time. Then, the second component is seasonal trend.

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Generally, the seasonal trend is the seasonal variation in the data within a year. So, suppose that this is if you look at it, we take a product that this is the demand for ice cream. So, what would be the seasonal variation here? So, obviously in the summer, it is going to be high in the winter and rainy season, it is comparatively low.

This variation will be there throughout the time series data within a year. In each summer, the variation is there because there is an increase and the other part, it is decrease. So, seasonal trend is generally similarly, if you take the case of a winter garment obviously, the demand has to be more in the winter season and less in case of summer season.

So, in this case, we need to see the product is what kind of product, whether it is a seasonal product. If it is a seasonal product generally, the variation is within the year in that specific season, where the data will generally being used or the product generally is used.

Then, the third component is cyclical trend. Here, there is a cyclical movement for the demand for a product that may have a tendency to recover in a few years. So, if you remember about the business cycle or we discuss about a business cycle generally, the economic activity follows a different path. Sometimes, it goes to the boom. Sometimes, it goes to the recession. Similarly, in case of a cyclical trend, the trend also follows a

cycle and it increases. Then, after sometime, it decreases and the same increases get followed also in the next time period.

So, whether it is a boom, whether it is a recession, it follows the same kind variation in next time period or may be after a few time periods. That is why this trend is cyclical because this is cyclical movement. So, if it is increasing now, it does not mean that in the next period, it has to increase or in the next period again, it has to increase. It follows a cycle. If it is increasing now, may be after few years or may be after few months, whatever may be the basis for the data on that basis, it may increase again.

That is why this cyclical trend is, the possibility here is or the tendency is that the same kind of change or the same kind of variation has to recur in a few years. So, cyclical movement in the demand in the demand for a product that may have the tendency to recur in the few days or few years, in the few months, whatever may be the basis for the time series.

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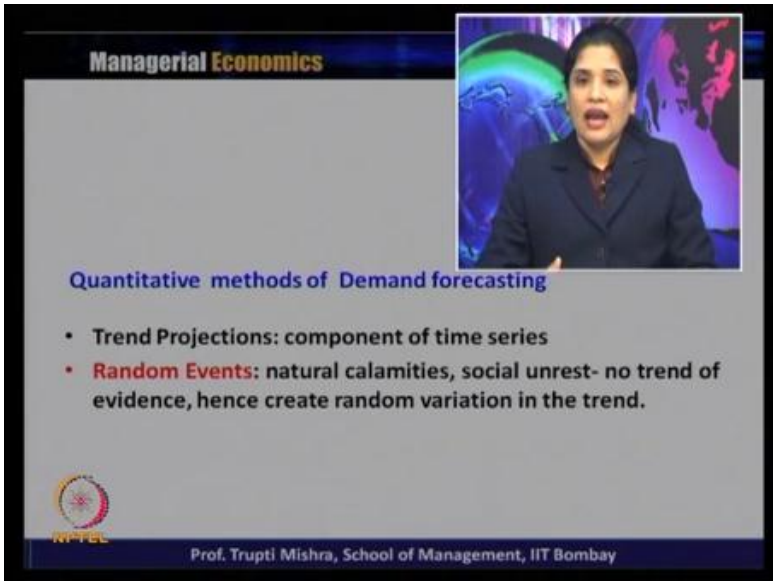

Then, the last component of the time series is the random event. What are random events? Random events are generally, when the variation comes from the random events and what the typical variations of it are. If you take the case of natural calamities, it is your social unrest. In this case, there is no trend of evidences to create a random variation in this trend.

This is because the social unrest is happening. It is not happening very frequently that there will be evidence in each year 10 times. This is the demand when there is a social unrest. It is not a regular picture. If it is not a regular picture, the evidence, it is difficult to find in the time series data, may be social unrest before 20 years than social unrest now. So, since this time series, suppose in this case, we are taking a data series of last 5 years. If there is no evidence of the social unrest in the last 5 years, whatever the variation in this case, particularly for the social unrest that has to be random and because this is a random event.

Similarly, for the natural calamities like if the flood is happened this year and if the flood is not happened in the 5 years, whatever the effect on the demand, that will be the of course, the effect of because of the effect of trend due to natural calamities. It is always the random because it has not happened in the previous time period. So, when the variation occurs due to random event variation has to be random because there is no evidence of such kind of variation in the trends.

So, there are 4 components of price, time series data. One is the cyclical trend. Second is the random event. Third third is the seasonal trend. Fourth is the secular trend. Now, what are the components of this time series?

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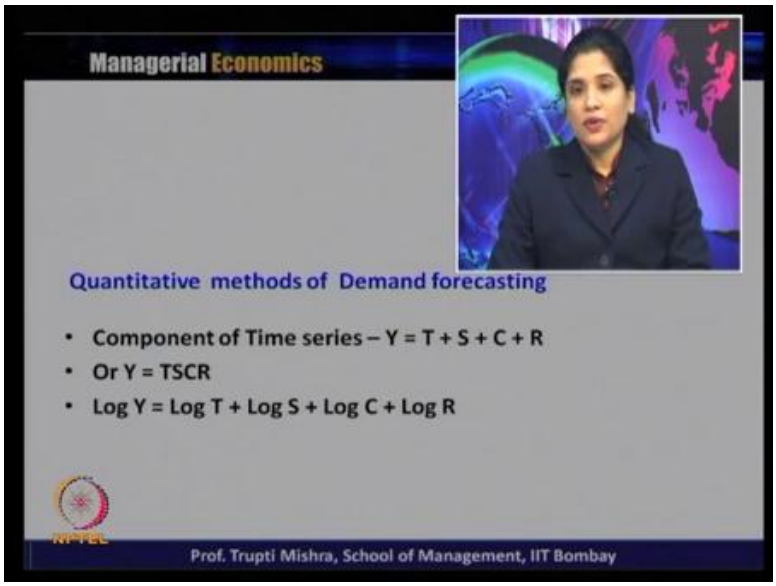

So, this whatever the component we discussed here, if you can put it in the formulate in the equation form, then Y, that is if it is a time series that has to be equal to the T plus S

plus C plus R. Here, C, S is the secular trend. C is the cyclical trend. R is the random event. T is the seasonal trend.

So, this can be in addition form or it can be in the also in the multiplication form. So, the first one is that is T plus S plus C plus R is the additional form. Y is equal to T S C R can be the multiplicative form.

If you are taking the logarithmic, logarithmic transformation of this multiplicative form, then we will get log Y is equal to log T plus log S plus log C plus log R. So, here the entire trend has 4 kinds of components. This can be done, this can be formulate either in the additive form or in the case of the multiplicative form and multiplicative form again, we can transform into the logarithmic form. Now, what are the methods for this trend projection?

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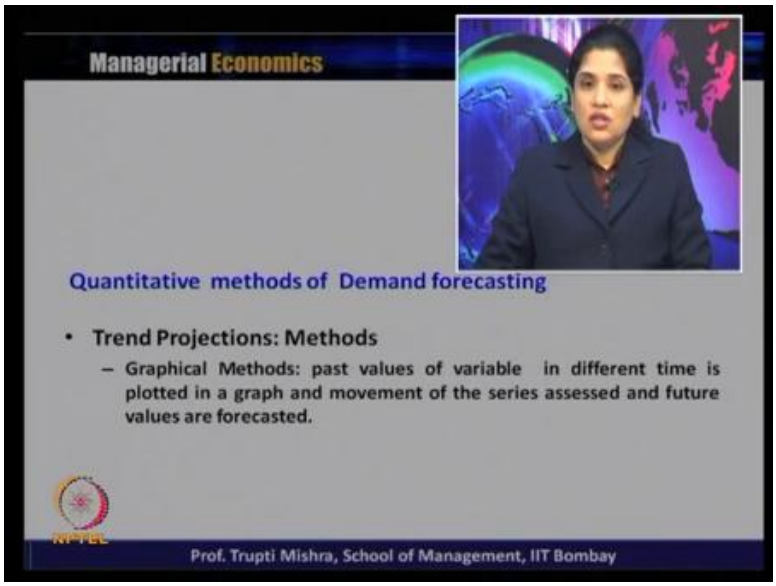

So, till the time, we are talking about the components of the time series data because for the trend projection, the basis is time series data. Now, we will see what are the methods for the trend projection? What are the methods for trend projection? The first one is one is the graphical method. As the name suggests, generally, in this case, projection will be done using a graph. The past values of the variable in different time are plotted in a graph and movement of the series is assessed and the future values are forecasted.

So, in this case, we will identify here. Here, we need to forecast the demand. So, in that case, we will see what are the 2 variables to forecast the demand? May be on the basis of the advertisement, what will be the, what will be the sales or in the different or may be in the different time period or in the previous time period or in a specific time period what was the demand for the product?

So, time and quantity, we will plot it in a graph. We will follow that, we will see the series, we will plot a line. We will see the series and after looking at the series, we can forecast that if this was the trend in the last 5 years, what is going to be the trend and what will be forecasted demand for this product in the next 5 years. So, looking at the past trend using the graphic method, generally, we can forecast the future trend. So, we will take a graphical explanation to these graphic methods.

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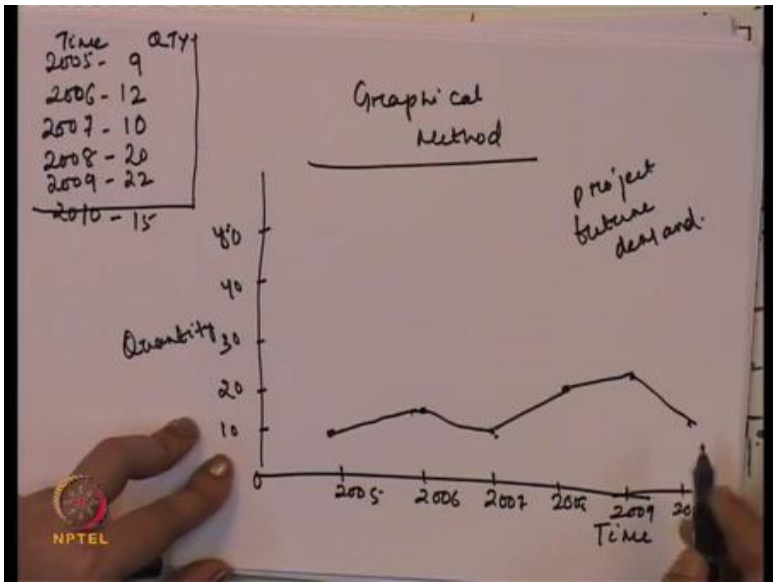

How generally this trend is, how the projection of the trend is done in case of the graphical method? So, here, we can take time. Here, we can take quantity. Suppose that this is 2005, 2006, 2007, 2008, 2009, and 2010. So, here it is 0. Sorry, this is may be 10. This is 0. This is 20, this is 30, this is 40, this is 50 and so on.

So, suppose that we have the data about last 5 years 2010 or the last 6 years, that is from 2005 to 2010. So, suppose that in 2005, we have the 2005. We have 9. This is the time and this is the quantity. So, 2005, it is 9. For 2006, it is 12. For 2007, this is 10. For 2008

again, we can say this is 20. For 2009, it is 22. For 2010, may be again, we can say this is 15.

Now, if you plot this for 2005, this is nine. For 2006 this is 12. For 2007, this is 10. For 2008, this is 20. For 2009, it is 22. For 2010, it is 15. So, if you look at here, this is the trend for the quantity. This is the trend for the demand in the last 5 years. So, if you look at now, from 2005 it increases again. It decreases in 2007. Again, it increases in 2008, 2009 and decreases in 2010. On this basis, now, we need to project the future future demand on the basis of this past trend.

So, graphical method generally, first plot it look at that. How is the series? How is the movement of the series assessed and then the future value forecasted? Now, it has to see that why the value is less, why the demand is less in 2007 or why it is following a decline in trend in 2010? So, on this basis now, the series will be assessed that why in a specific year or why in a specific time period, the demand is more or demand is less whether the same thing has to be taken in to consideration when we are forecasting the demand for the next 5 years.

Also, in this case, the graphical method is simply plotting the data of the dependent and the time time and the demand in the past time period. After putting in the graph, the series will be assessed and the future value will be forecasted. So, in the trend projection method, the first method comes as the graphical method. Then, we will take the least square method. What is least square method?

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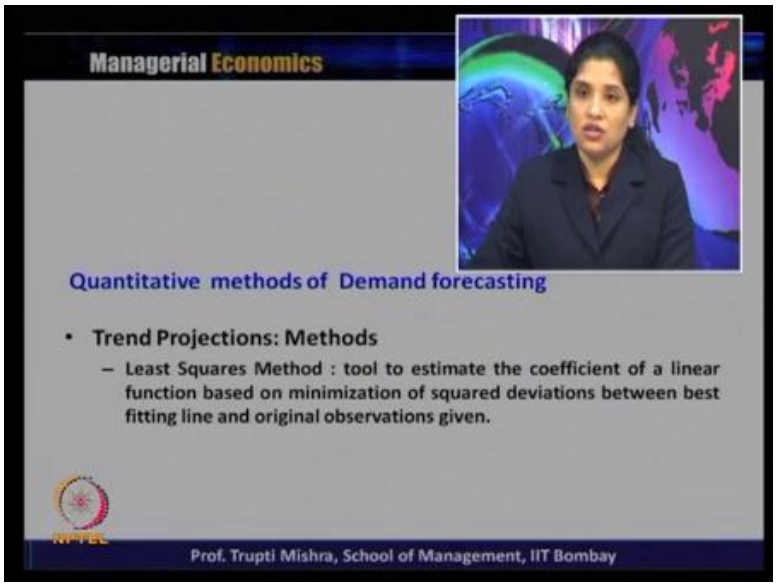

If you look at it, if you remember this we discussed this when we are discussing about the regression. This typical least square method and this basically, the tool to estimate the coefficient of a linear function based on the minimization of the square deviations between the best fitting line and the original observation given.

So, if you remember when we discussed about the regression that we get the error because whatever the regression and whatever there is a difference between these 2. Since, there is a difference between these 2, there is it gives us the error. So, to minimize the error on the basis of the square deviation between the best fitting line and the original observation generally, the method of least square is used.

This method of least square is also being used to project the forecasted demand. How this demand will be forecasted on the basis of the least square, we will just see that. We will just find out the value of a and b. After finding out the value of a and b, and after finding out the value of a and b on that basis, we can forecast because b gives us the slope.

Slope generally gives us whatever the, whatever the increase in the dependent variable when this typical variable changes. That is why on that basis, we can project the demand. So, here, we will take the least square method to understand this.

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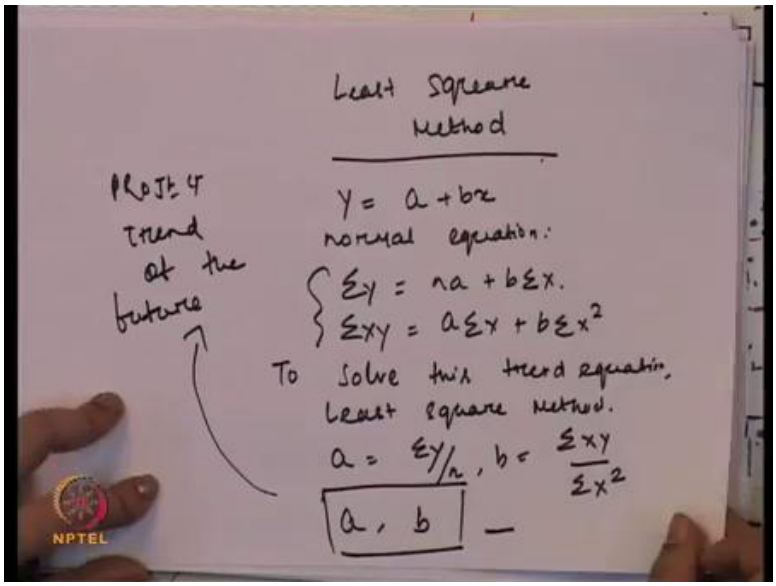

So, here Y is equal to a plus b x. From there, we get the the normal equation because this is the case of the minimization. We get the normal equation as sigma Y is equal to n a plus b e x and e x Y is equal to a e x plus b e x square. To solve this equation, these are the trend equation and on that basis, we need to first solve the value of a and b.

This is because this is the trend equation. On the basis of the value of a and b now, we can find out what will be, we can find out what will be the value of the future, in the future time period. What will be the value of a and b? Now, what is a and b? Here, a is the value of the intercept and b is the value of the slope. The value of intercept and slope will decide what will be the demand for the product in future time period.

So, to solve this trend equation, we have to solve this trend equation. For solving this, we need to follow the least square method. Following this least square method, we get a is equal to e x by n and b is equal to e x y by x square. So, here Y is our dependent variable and x is the independent variable. This is the sum of the dependent variable by the number of observations. This is the sum of both x and y dependent and independent variables divided by the square deviation of the square root of the square of this independent variable.

So, once we get the value of a and b, on that basis now, we can project whatever the trend of the future. So, in this case, in the trend projection, in this first method, we generally do it through the graph. We plot the graph with t dependent and independent

variables or the time typically, the past time period. Whatever the demand, we plot it in the graph. On that basis, we generally arrange the series. On that basis, we forecast the value of the demand in the next time period in the case of least square method.

We generally follow the least square method of solving the normal equation, finding out the value of slope and intercept. Once we get the value of slope and intercept on the basis of the past data, then we can project the project the future a and b because a is the intercept. b is the slope. On that basis, demand is dependent on whatever the change in the independent variable. So, once we get a and b on that basis, we can plot can plot or project the project what will be the future trend or future demand of this product. Then, the third method is arima method.

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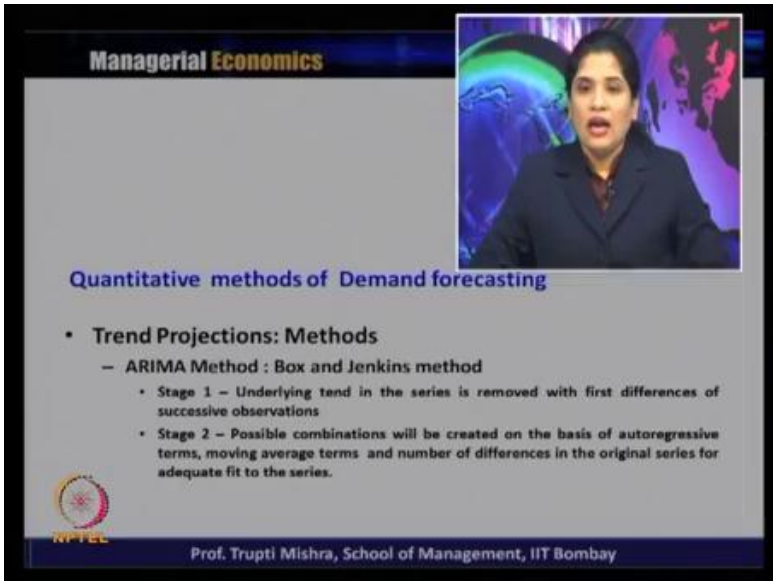

This method is also known as the Box and Jenkins method. How generally this arima method is being followed? To do this trend projection in the stage 1, we need to; underlying the trend in the series is removed with first differences of the successive observations.

So, whatever the trend in the underlying series that has to be removed with the first differences. We need to take the first 2 derivatives of the successive observation. In the stage 2, possible combinations will be created on the basis of the autoregressive terms, on basis of the moving average terms and the number of differences in the original series of adequate fit to the series.

So, there will be possible combination will be created on the basis of the autoregressive terms, on the basis of the moving average terms. Arima method is one, which also considers the autoregressive term and also the moving average term. So, in this case, the possible combination will be created on the basis of the autoregressive terms and the moving average terms. Then, the number of differences in the original series will be adequately fit into the series.

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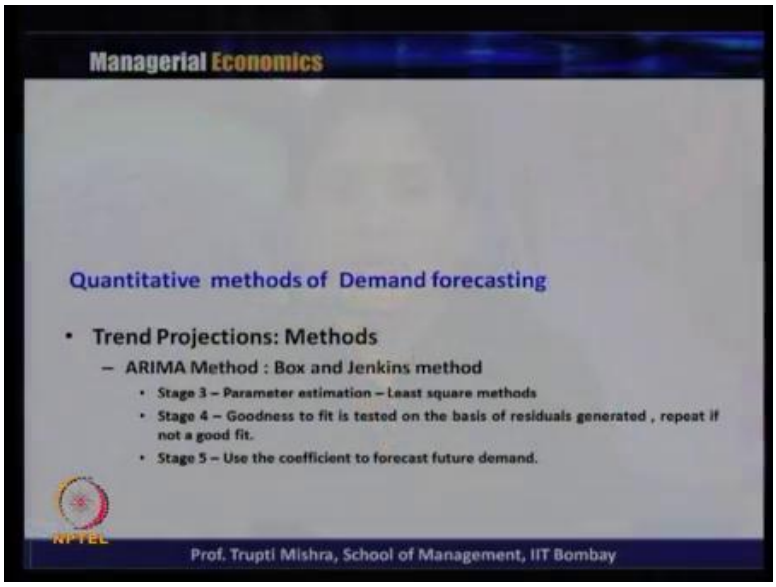

Then, there is stage 3. The parameter estimation will be done and for doing the parameter estimation, the parameter estimation will follow the least square methods. The stage 4 is generally to do the goodness of fit that is tested on the basis of the residual generated repeat if it is not a good fit. So, initially, we will take out the underlying whatever the trend in the series. Then, we will find out the combination on the basis of the moving average and on the basis of the autoregressive terms, we then will do the parameter estimation following the least square method.

The stage 4 is generally the goodness of fit to find out what is the overall explanatory power of the model. In this case, generally, if you find that this model is not going to fit, then again we have to start from the stage 2 where gain we have to find out the combination with reference to the moving average term and also the average regressive term. In the stage 5, you find that this model is qualifying the goodness of fit or the level of significance is acceptable.

Then, we will use the coefficient to forecast the future demand. So, stage 1 is always to start with whatever to remove the underlying trend in the series. Stage 3 is the parameter estimation on the basis of combination of stage 2. The stage 4 is goodness of fit. Here, we need to see that if it is misfit generally, we need to repeat stage 2 again.

Finally, stage 5, whatever the coefficient we get on that basis, we can forecast the future demand. So, graphic, so trend projection methods under quantitative method, trend projection method is one where we generally use the graphical method or the least square method or the arima method to project the future trend or the future demand. Then, we will come to the smoothing technique. Why the smoothing technique is required?

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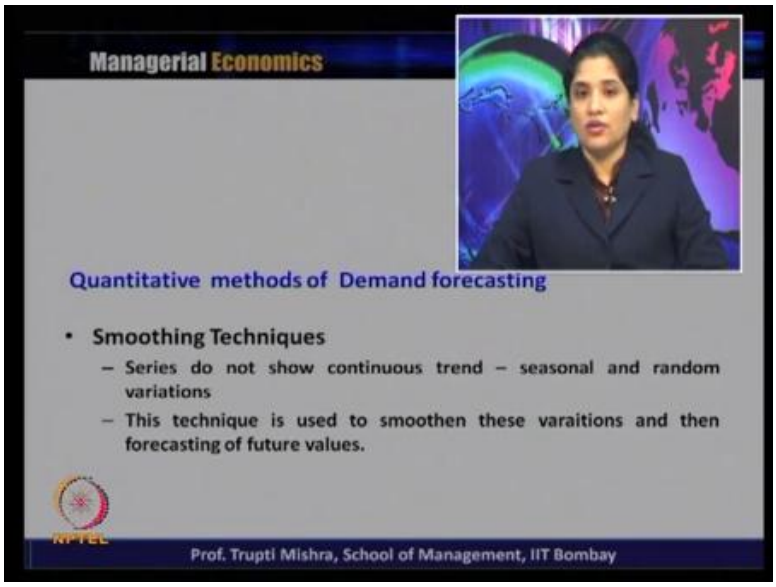

The series do not show continuous trend. There may be seasonal and the random variations. As we discussed, there may be the secular trend, the seasonal trend, the cyclical trend, there may be the random variations. So, series do not show continuous trend, either there is seasonal variation or there is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

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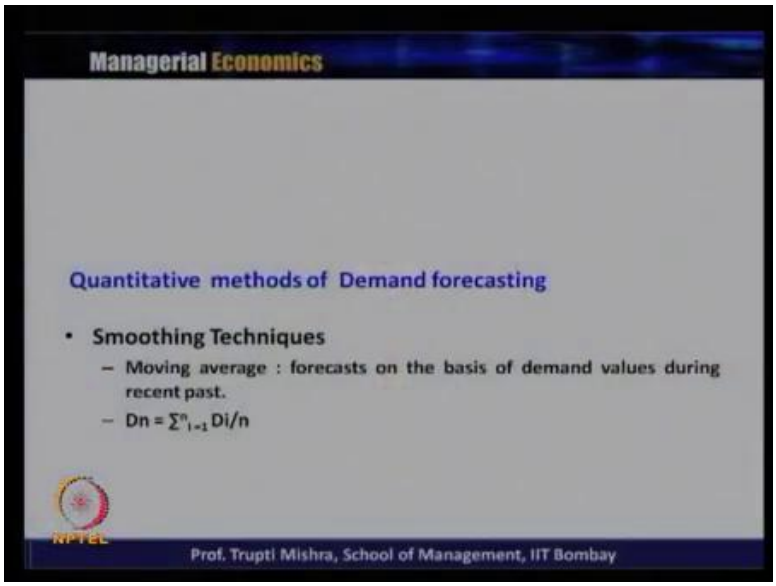

So, there are 3 methods of smoothing technique. The first one is moving average and in the moving average method, it forecasts on the basis of the demand values during the recent past. So, here, if you take D is the demand, the time period n, in this take, we take the D n. That is the sum total of the 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, 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.

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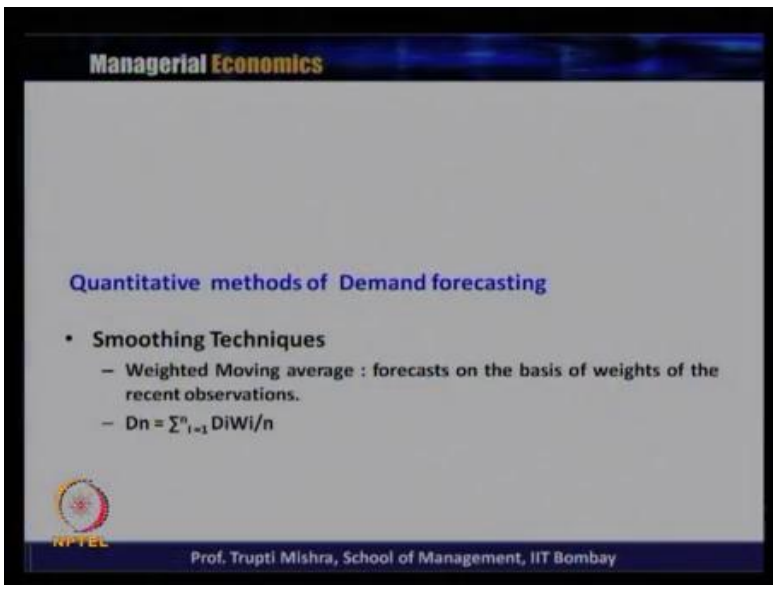

The the second method is the weighted moving average is the forecast based on the weights of the recent observations. So, here if you at the demand is in the basis also not only the demand in the previous time period, but also whatever the weight to this demand in the previous time period, whatever the 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.

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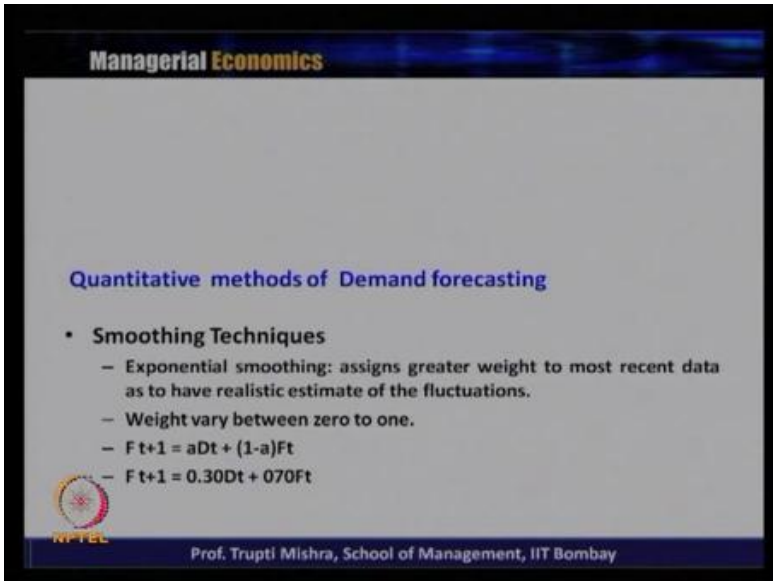

In case of exponential smoothing, generally, it assigns a greater weight to most recent data to have a realistic estimate on the fluctuations. So, this is again the more improved, more revised in form of whatever the weighted smoothing technique. In this case, it generally assigns, this technique generally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

So, 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 n years. In this case, the weight is given more to the specific year, which is just before this present year. 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 here if it is in the forecast in the next time period that is t D 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, it is more dependent on the past 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 0.3 for the demand for the rest of the period.

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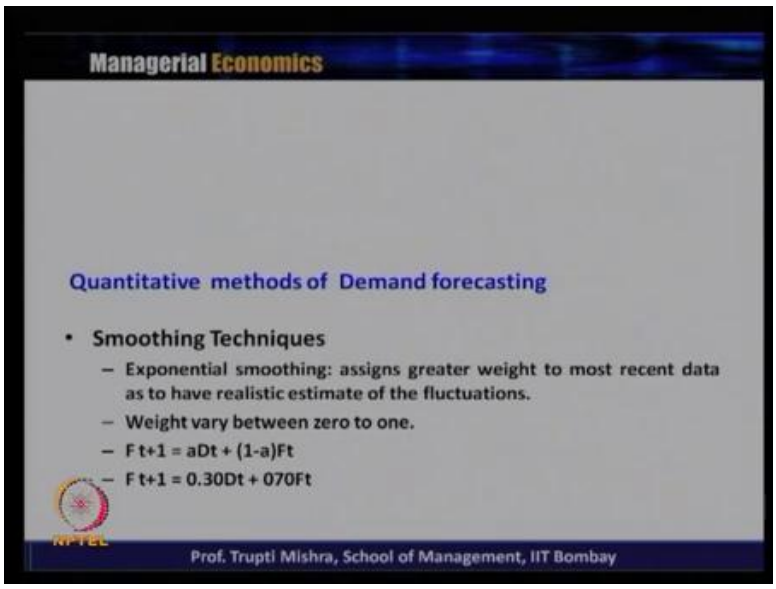

So, F t plus 1 is equal to 0.30 plus 0.30 F t. In this case for the future forecasting of demand, for the next time period, for the present time period it is t. For the next time

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.

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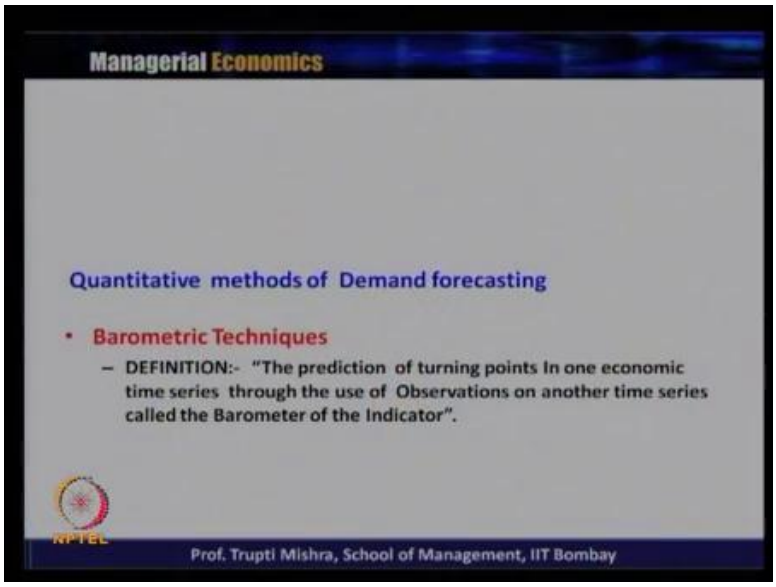

What is barometric technique? Barometric technique is, to define it, it is the prediction of the turning points in one economic time series to the use of observations on another time series called barometer of the indicator. Generally, barometer is one who records this activity or generally we crystallize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

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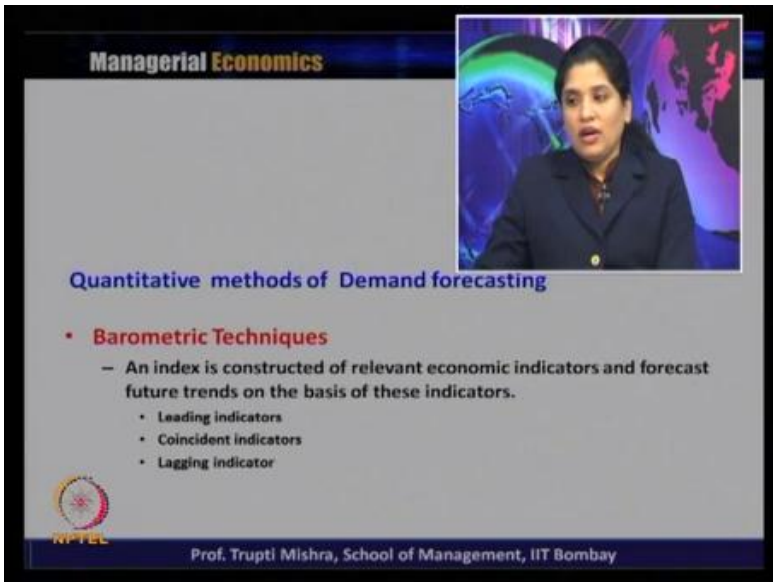

So, in the barometric technique, generally an index is first constructed on the relevant economic indicators and forecast future trend from the basis of these indicators. So, what, how this barometric technique is being practiced? Index will be constructed and what will be component of the index? The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

Once the index is constructed, the 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. The first one is the leading indicator. The second one is the coincident indicator. The third one is the lagging indicator. What is a leading indicator?

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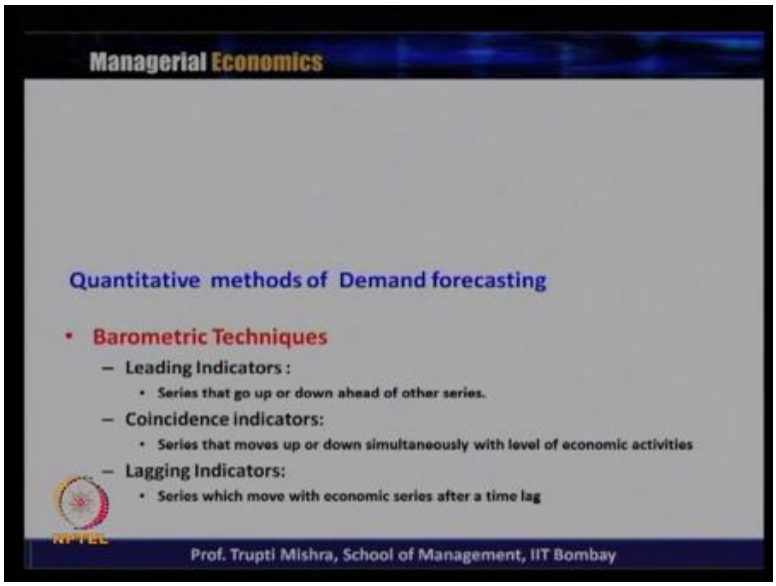

A leading indicator is one which goes up or down ahead of the other series. So, if the one series is about price quantity and the other is about the income quantity, in this case of the price quantity series is always going up the income quantity series. We can say that the price quantity, they are the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

Then, we have a coincidence indicator. What is a coincidence indicator? It is typically a series that moves up or down 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 down, it will follow a regular trend and that is why it is called as the coincidence indicator. In 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 it with 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?

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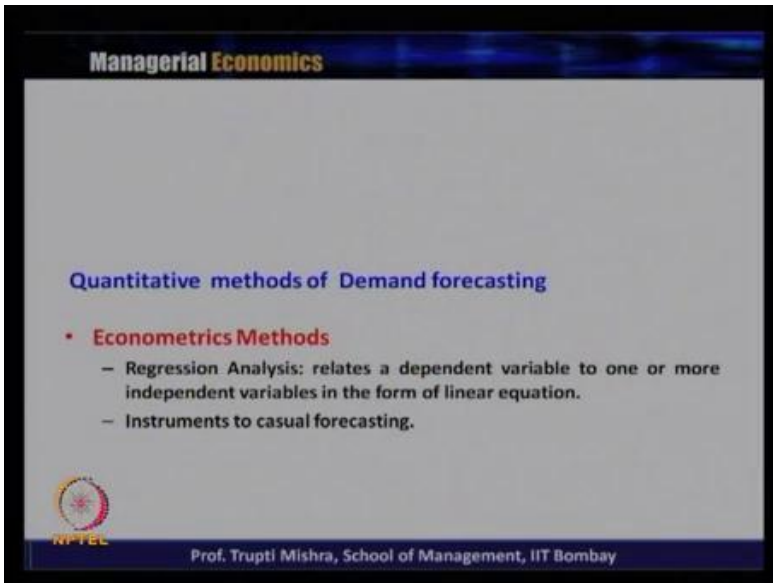

We take two kinds of analysis, one is the regression analysis and the second is the simultaneous equation method. Regression analysis generally relates a dependent variable to one or more independent variables in the form of a linear equation. As we discussed, when we were discussing about the regression 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.

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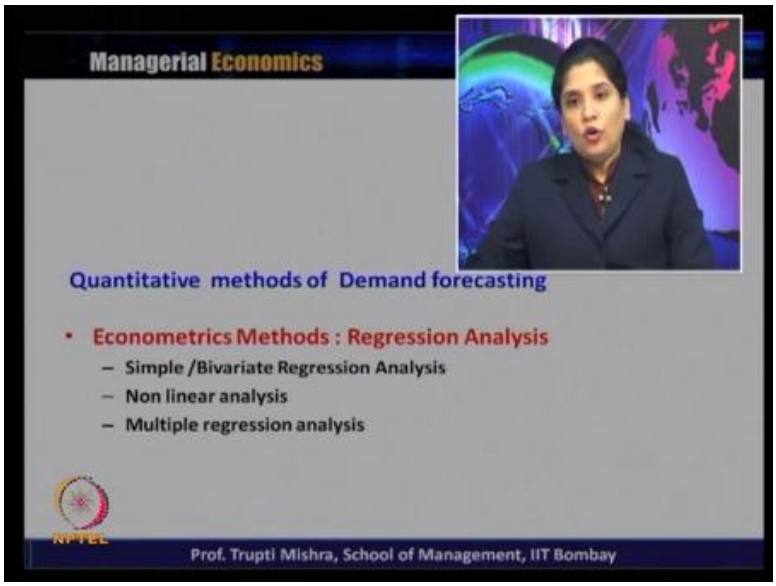

So, before that, we will see that there are 3 types of regression analysis. One is simple or bivariate regression analysis, where it is basically the relationship between 2 variables, 1 dependent variable and 1 independent variable. They are linearly related in case of 2 variable regressions. Also, they are not related in a 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 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 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.

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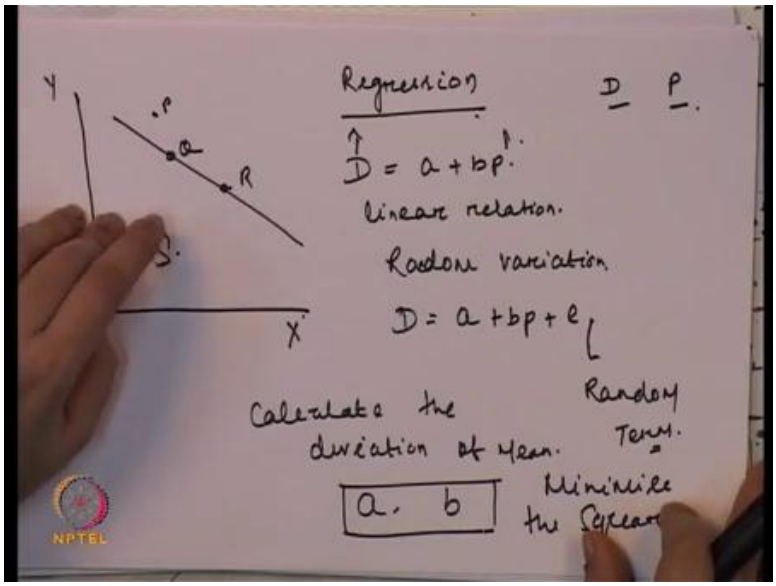

So, if you are taking an analysis, an analysis of simple regression example of simple regression analysis is suppose that D is equal to a plus b p. Here, we say that both the variables are linearly related. There is a linear relation between D and p. So, D is the dependent variable, p is the independent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

Now, if you plot it, we have different series of the values for D and p. We will get the combination here. May be if you plot in the graph, we will get one combination is P, another combination is Q, another combination is R and another combination is S. So so, when p takes a value, what is value of D? When p takes a different value, what is the value of D?

In that basis, we get all this point. So, this point talks about how both of them are related. Now, here of you look at this is the regression line. If they are, if this, they are the combination between p 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?

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

Now, in order to minimize this random term, we need to calculate the deviation from mean or we need to calculate 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 data point.

Here, we are trying to here; we are trying to manage that whatever the deviation on the regression line and on the points on X that we generally need to minimize this. 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 actual difference between the actual data point, actual data point and the regression.

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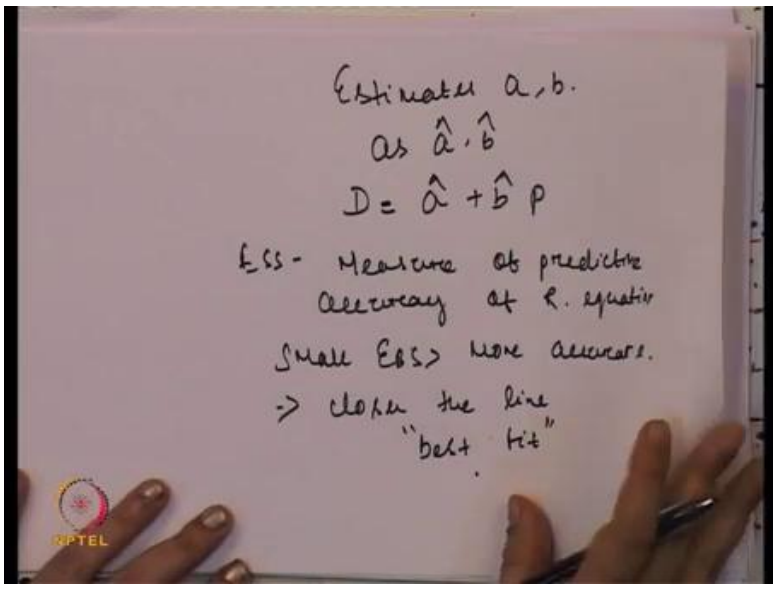

Then, we get the estimates of a and b in that point. So, once we get the estimates of a and b, this is as a cap and b cap. The new regression line will be a cap plus b cap p. Here, we sat that these values of a and b take care of the of the deviation from the regression line and the actual point.

Here, we get the time term that is deviation square. This is the major of the predictive accuracy of the regression equation. So, if it is smaller ESS, if the value of this is small, the 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. Then, the regression line is minimal.

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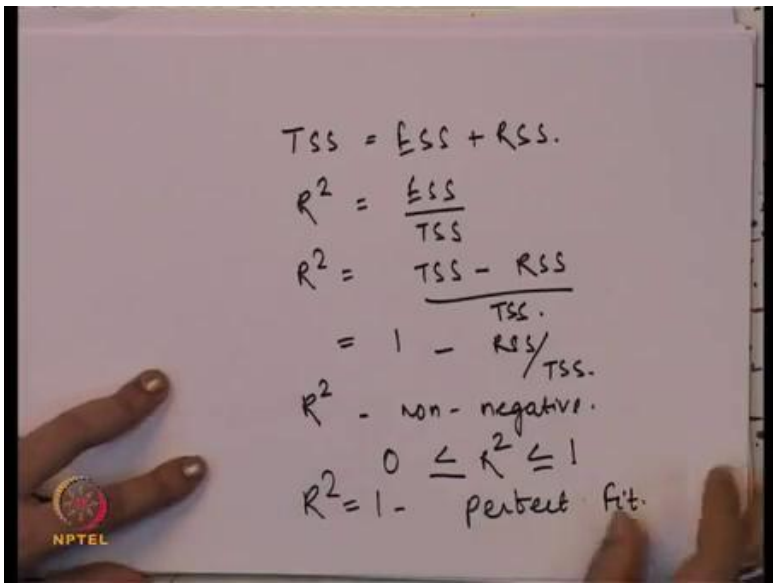

Now, we find out the the coefficient of determination to find out that these 2 variables how they are related? So, to find this, we need to find the total sum of square. Total sum of square is the expected sum of square plus the residual sum of square. So, R square is expected sum of square and residual sum of square. We can just write R square this 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 exponential 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 in the regression line in the actual data points. We can forecast the demand. But, what are the challenges that are being faced, when we use the regression method to forecast the demand?

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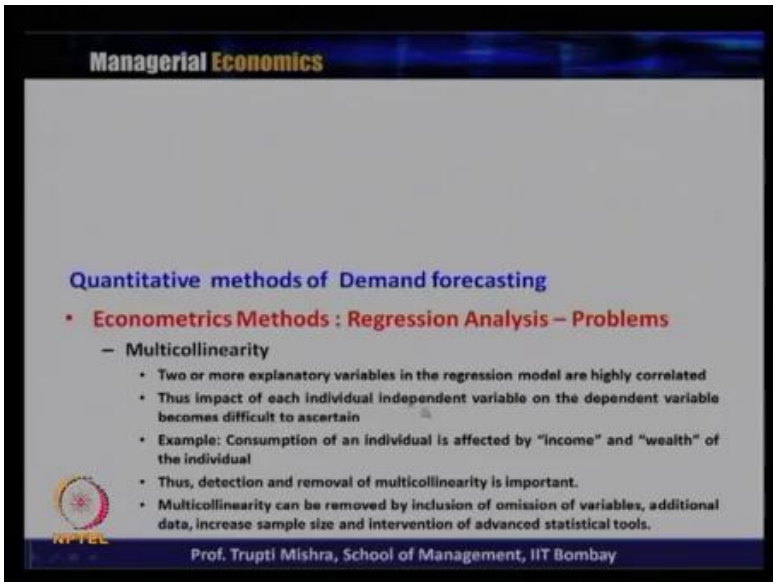

The first problem is multicollinearity. Here, two or more explanatory variables in the regression model are highly correlated. That is why; we call it a multicollinearity problem. Since, they are highly correlated, the impact of each individual independent variable on the dependent variable becomes difficult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

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

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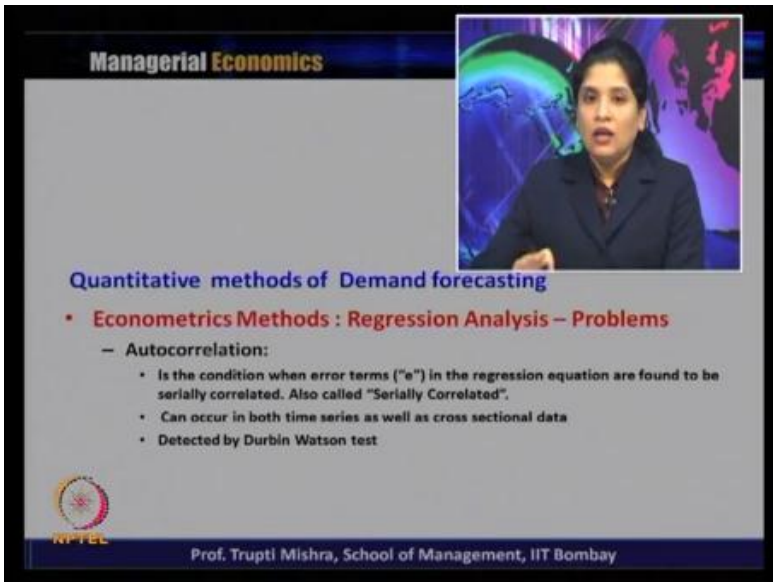

The second point is autocorrelation. When we get this condition of this autocorrelation, this is the error terms e in the regression equation are found to be serially correlated or also called as serially correlated rather than autocorrelation. It can occur both in time series as well as cross-sectional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

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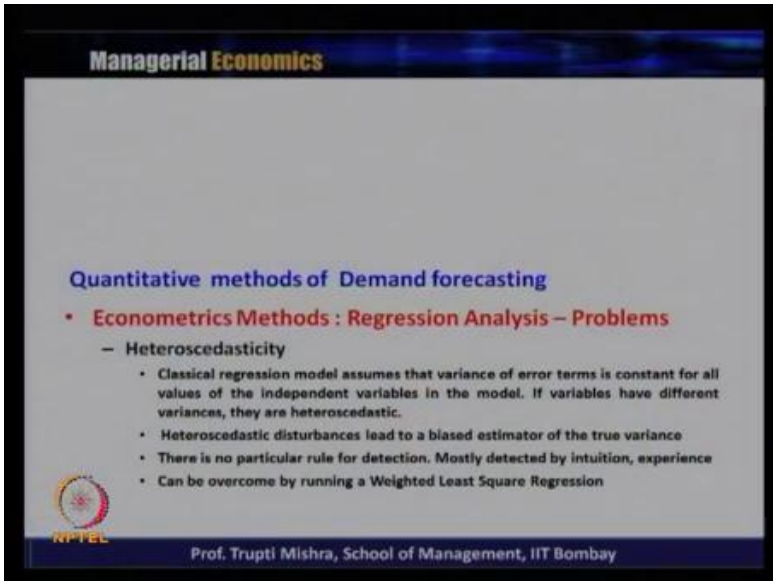

What is the problem of heteroscedasticity? Because the regression model always assumes that the variance of the error term is constant for all the values of the independent variable in the model. But, if the variables have different variances, we generally land into the heteroscedasticity situation.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

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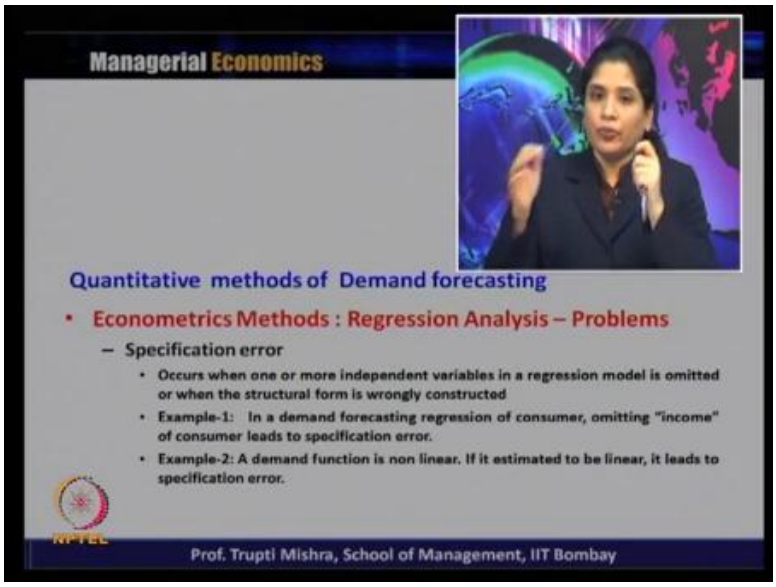

The detection of heteroscedasticity mostly, it is detected by the experience. It can also be detected by the running the weighted least square regression like giving a weight to each of these variables or by the specification technique. The weighted average mean of the weighted least square can be used to solve this problem of later in the regression model is omitted. The structural form is wrong means not structured.

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, there is identification problem.

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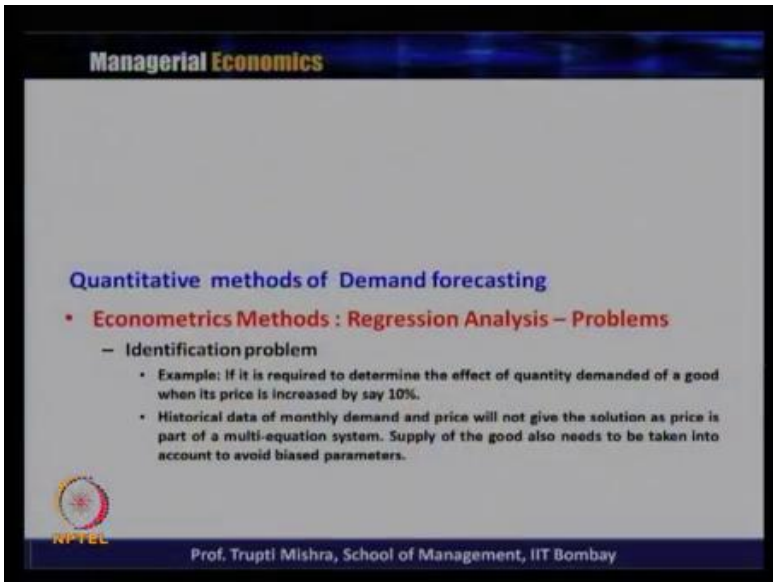

Typically, this is the typical example taken in case of identification problem. It is if it is required to determine the effect of the quantity demanded of a good when the price is says increased by 10 percent. Historical data of monthly demand and price will not give the solution as price is a part 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 the simultaneous equation method.

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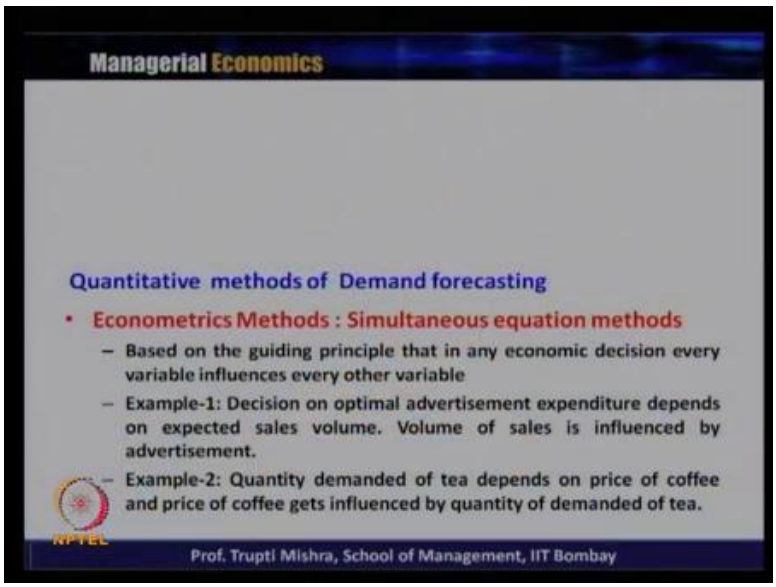

What is generally used to forecast the demand? Now, what is this simultaneous equation method? Based on the guiding principle that in any economic decision every variable will influence every other variable, so in any economic decision, every variable influences every other variable. Like you take the example 1 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 price of coffee also depends on the quantity of tea demanded. 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, there is a simultaneous and two way relationships between these 2 variables.

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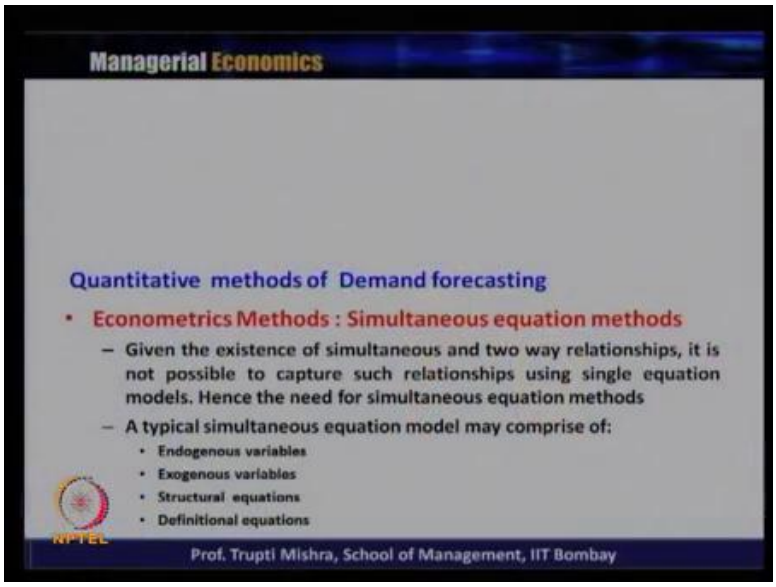

The variables, which influence for or which require to forecast the demand, if it is not possible to capture such relationship using single equation models, like the linear regression model. Hence, the need of simultaneous equation model comes from here. A typical simultaneous equation method comprises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

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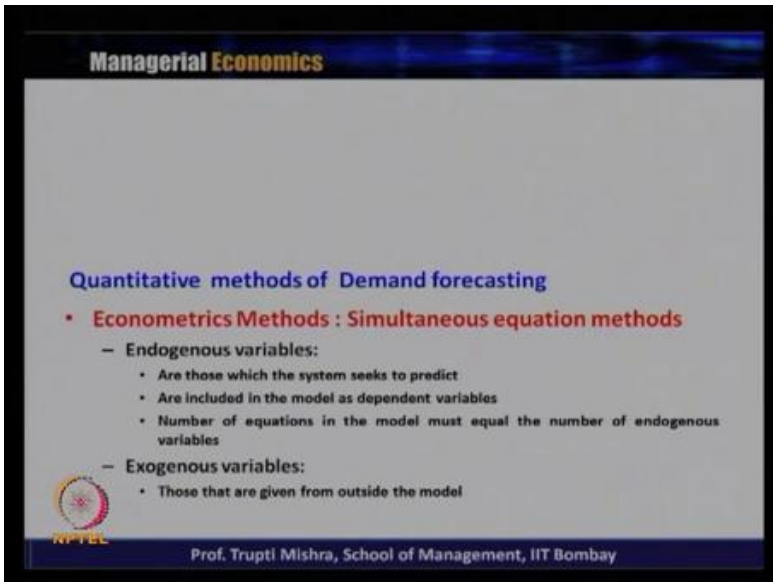

What is endogenous variable? Endogenous variable are those, which the system seeks to predict. They are included in the model as dependent variables. The number of equations in the model must equal to the number of endogenous variables. Exogenous variables are those are given from outside the model.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

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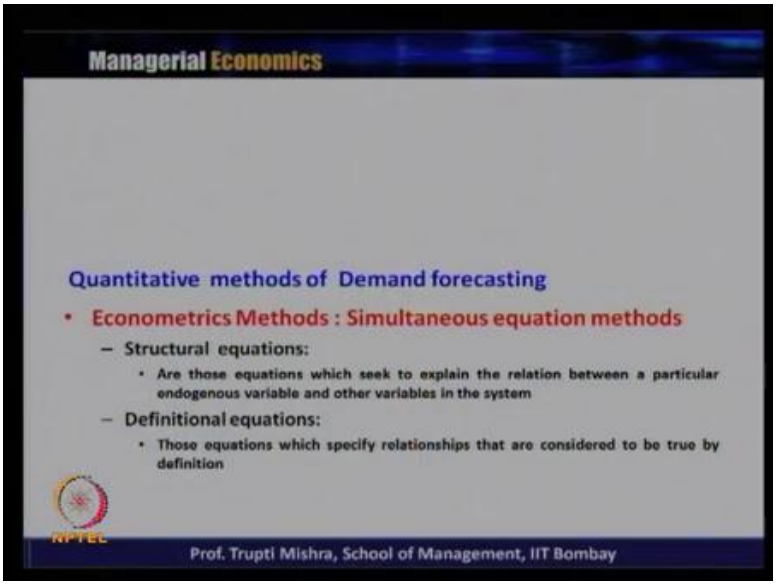

Structural equations are those equations which seek to explain the relationship between a particular endogenous variable and the other variables in the system. Definitional equations are those equations that specify the relationships that are considered to be true by definition.

So, throughout 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 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?

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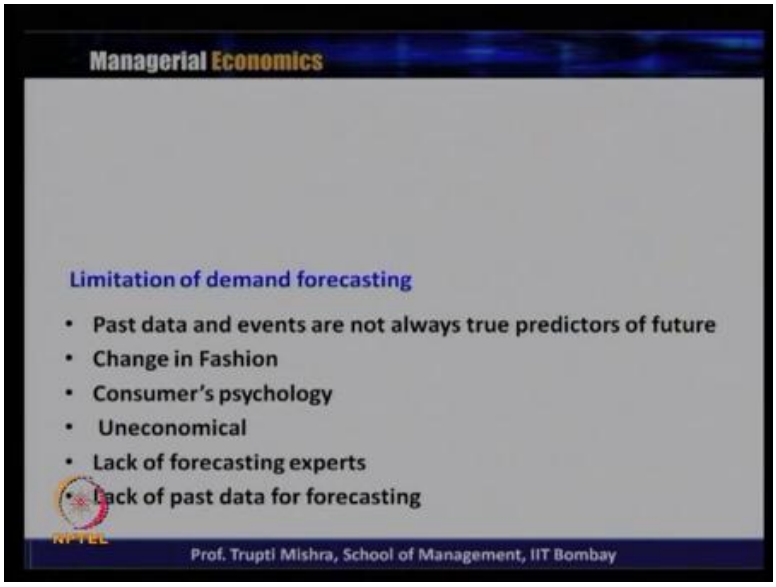

Past data and events are not always the true predictors of future because whatever the events that may not recur in the future time period. Also, about the trend, that also may not occur because as a whole, if you look at the time period, it is dynamic for the previous time period. The next time period 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. It creates another challenge for demand forecasting, especially for the economic organization.

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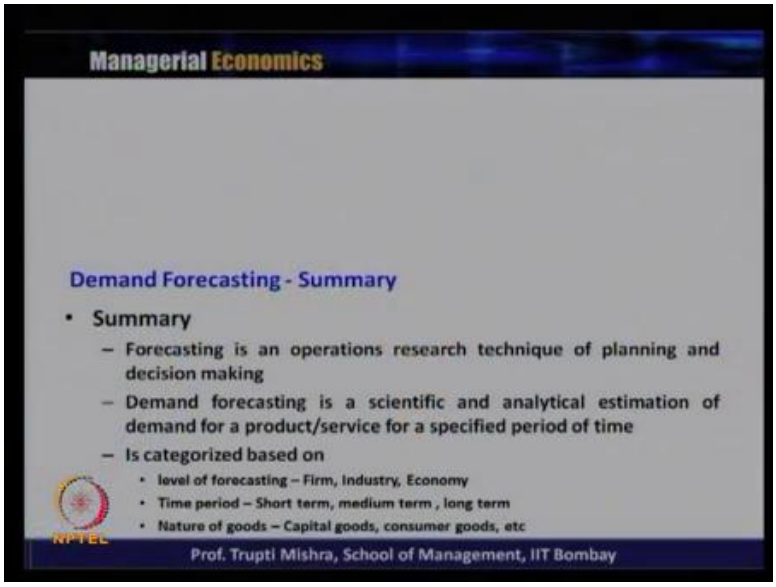

So, whatever we discussed in the previous session about demand forecasting and in today's session about demand forecasting to summarize, we can say that forecasting is an operations research technique for planning and decision making. Demand forecasting is a scientific and analytical estimation for demand 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.

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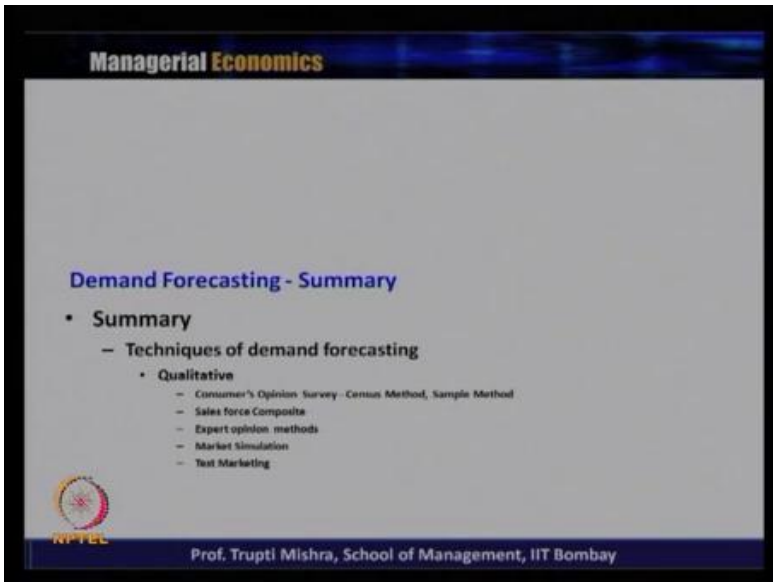

They are qualitative, where we consider the consumer's opinion survey, sales force composite, expert opinion methods, market simulation and test marketing. We have quantitative, where we discussed about the trend projection smoothing technique, barometric method and also the trigonometric method. So, 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.