Managerial Economics

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Lecture - 31

Demand Forecasting (Contd…) - I

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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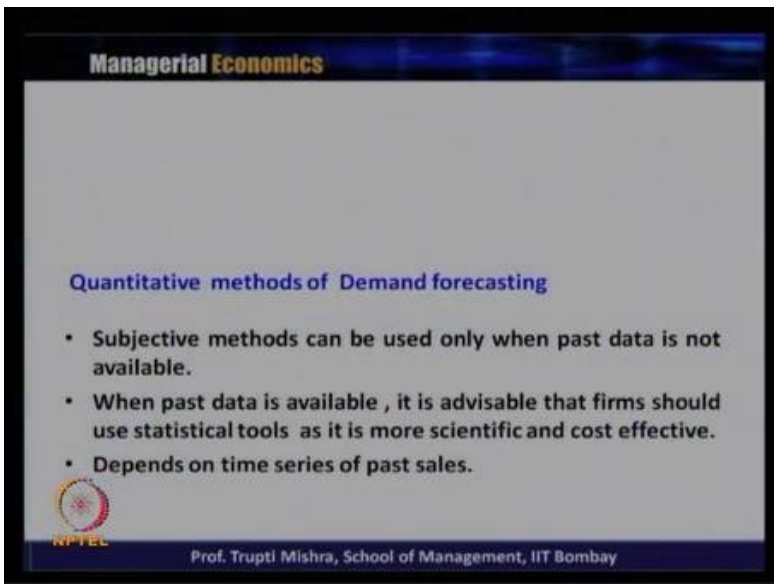

When the past data is available, it is advisable that the firms should use statistical tools as it is more scientific and cost effective. So, if you remember, the case of when we are discussing the subjective method, we also discussed that is subjective method is generally used if it is a case of a new 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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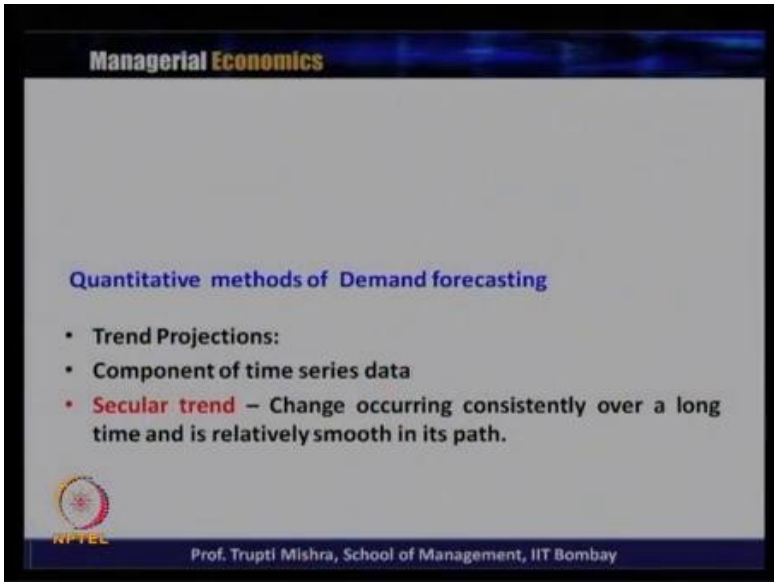

Here, basically we use the time series data. What is time series data? Time series data, when we keep the, when we record the information on a chronological basis, may be it is on a weekly basis, on a monthly basis, on a day basis, on a quarterly basis, hour basis or the yearly basis, when we order this, 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 known as 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 behaviour of that typical variable in the past time period. And 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 occurs 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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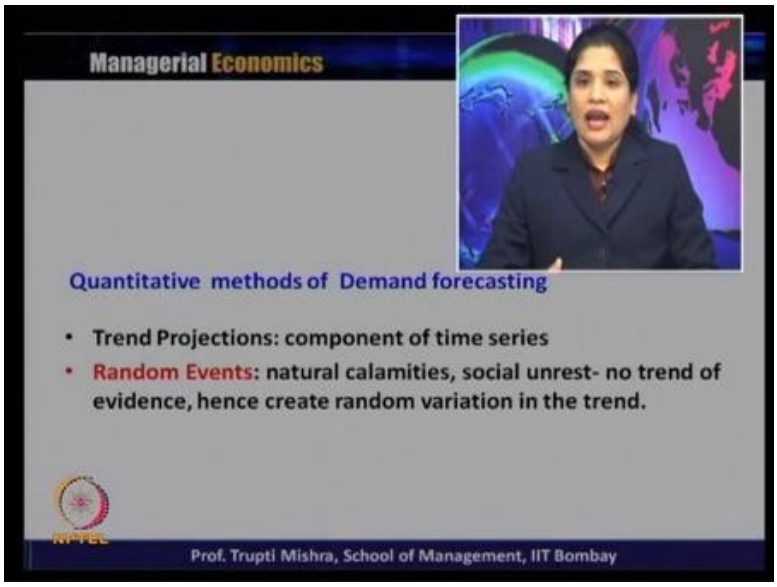

Then, the last component of the time series is the random event. What are random events? Random events are generally, when the variation comes from the random events and what the typical variations of it are. If you take the case of natural calamities, it is your social unrest. In this case, there is 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 feature. If it is not a regular feature, 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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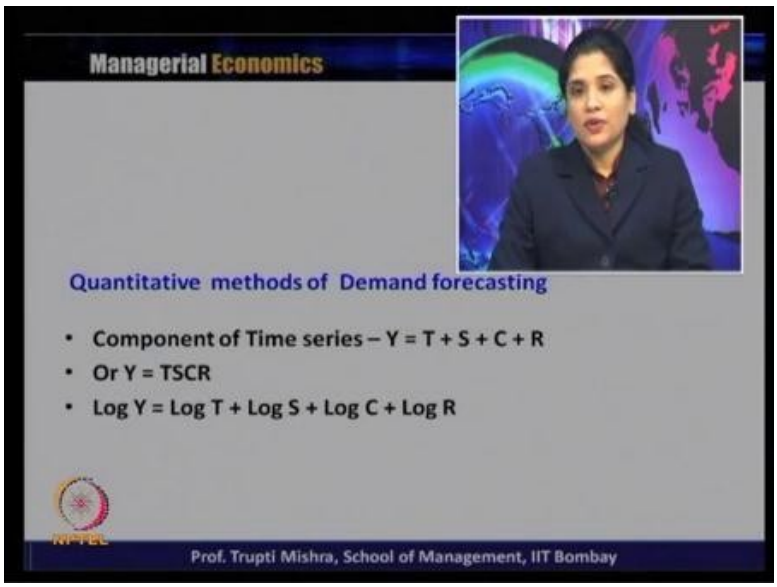

So, this whatever the component we discussed here, if you can put it in the formulate in the equation form, then Y, that is if it is a time series that has to be equal to the T plus S plus C plus R. Here, C, S is the secular trend. C is the cyclical trend. R is the random event. T is the seasonal trend.

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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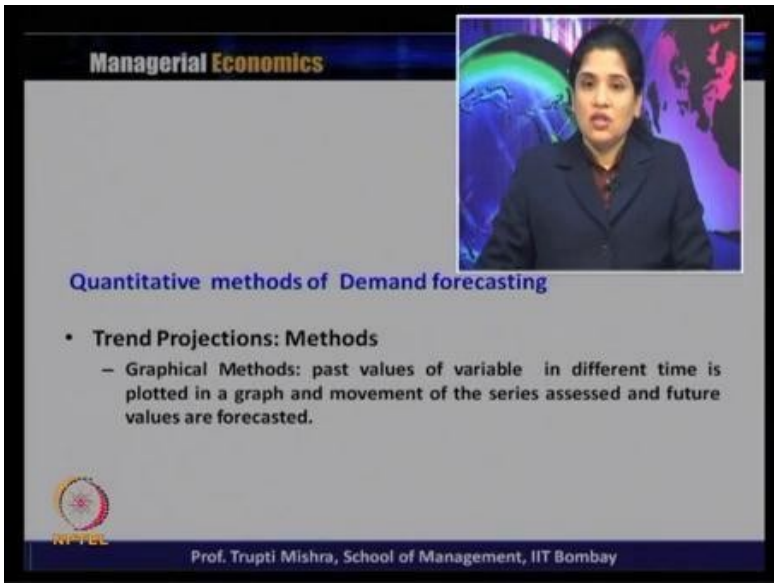

So, till the time, we are talking about the components of the time series data because for the trend projection, the basis is time series data. Now, we will see what are the methods for the trend projection? What are the methods for trend projection? The first one is one is the graphical method. As the name suggests, generally, in this case, projection will be done using

a graph. The past values of the variable in different time is 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 plotted 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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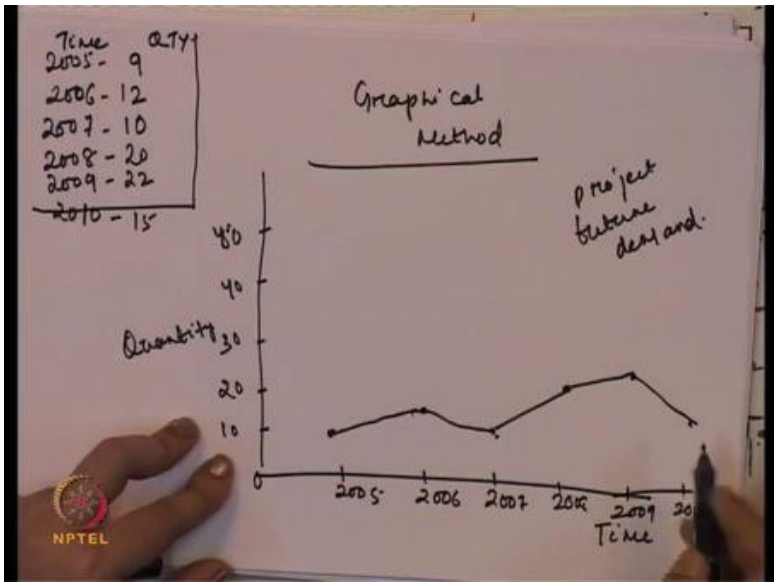

How generally this trend is, how the projection of the trend is done in case of the graphical method? So, here, we can take time. Here, we can take quantity. Suppose that this is 2005, 2006, 2007, 2008, 2009, and 2010. So, here it is 0. Sorry, this is may be 10. This is 0. This is 20, this is 30, this 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, this is 22. For 2010, may be this 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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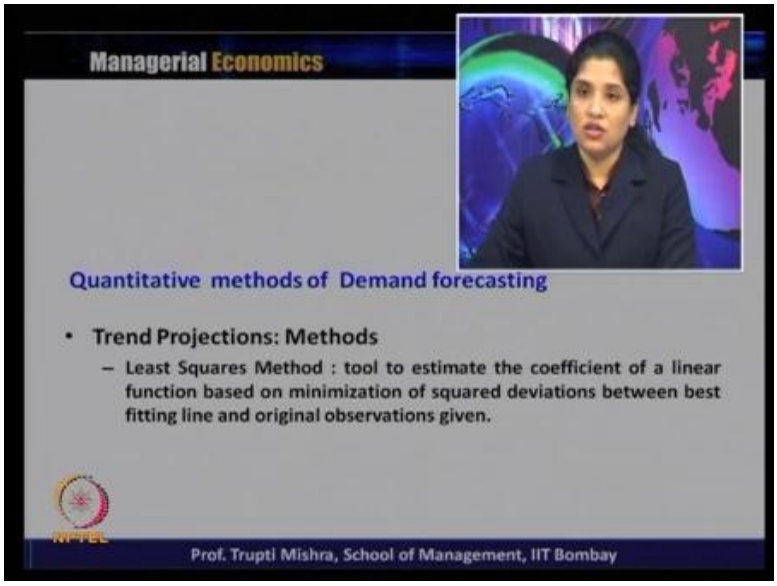

If you look at it, if you remember this we discussed this when we are discussing about the regression. This typical least square method and this basically, the tool to estimate the coefficient of a linear function based on the minimization of the square deviations between the best fitting line and the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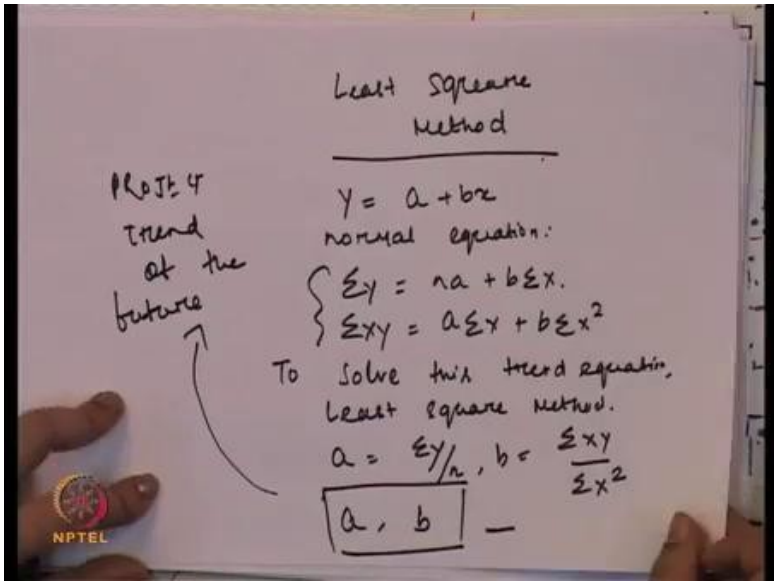

So, here Y is equal to a plus b x. From there, we get the normal equation because this is the case of the minimization. We get the normal equation as sigma Y is equal to n a plus b e x and e x Y is equal to a e x plus b e x square. To solve this equation, these are the trend equation and on that basis,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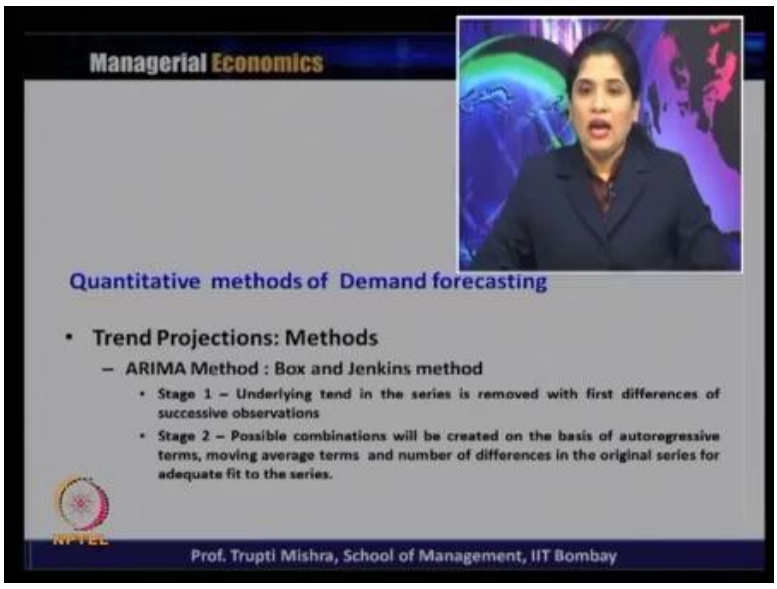

This method is also known as the Box and Jenkins method. How generally this arima method is being followed? To do this trend projection in the stage 1, we need to; underlying the trend in the series is removed with first differences of the successive observations.

So, whatever the underlying trend in the series that has to be removed with the first differences. We need to take the first 2 derivatives of the successive observation. then 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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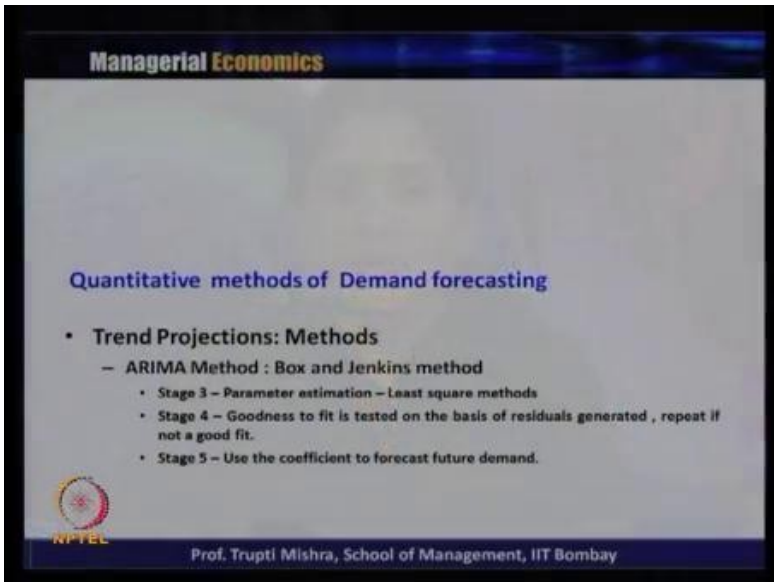

Then, stage 3. The parameter estimation will be done and the parameter estimation for doing that, the parameter estimation will follow the least square methods. The stage 4 is generally to do the goodness of fit that is tested on the basis of the residual generated repeat if it is not a good fit. So, initially, first we do the 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 to do the goodness of fit to find out what is the overall explanatory power of the model. In this case, if you find that this model is not going to fit, if it not 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.