SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLEGE ,MANNARGUDI.

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SUBJECT : BUSINESS TOOLS FOR DECISION MAKING

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E-CONTENT MATERIALS

UNIT-IV
Time Series Analysis

- **Definition of Time Series Analysis**
- Time series refers to an arrangement and presentation of statistical data in chronological order. The statistical data is collected over a period of time. According to Spiegel, “A time series is a set of observations taken at specified times, usually at equal intervals.” There exist various forces that affect the values of the phenomenon in a time series. These are also the components of the time series analysis. Learn the definition of Time Series Analysis here.

components of the time series:

- The various reasons or the forces which affect the values of an observation in a time series are the components of a time series. The four categories of the components of time series are
- Trend
- Seasonal Variations
- Cyclic Variations
- Random or Irregular movements
- Seasonal and Cyclic Variations are the periodic changes or short-term fluctuations.

- **Trend**
- The trend shows the general tendency of the data to increase or decrease during a long period of time. A trend is a smooth, general, long-term, average tendency. It is not always necessary that the increase or decrease is in the same direction throughout the given period of time.
- **Seasonal Variations**
- These are the rhythmic forces which operate in a regular and periodic manner over a span of less than a year. They have the same or almost the same pattern during a period of 12 months. This variation will be present in a time series if the data are recorded hourly, daily, weekly, quarterly, or monthly.

- **Cyclic Variations**
- The variations in a time series which operate themselves over a span of more than one year are the cyclic variations. This oscillatory movement has a period of oscillation of more than a year. One complete period is a cycle. This cyclic movement is sometimes called the ‘Business Cycle’.
- **Random or Irregular Movements**
- There is another factor which causes the variation in the variable under study. They are not regular variations and are purely random or irregular. These fluctuations are unforeseen, uncontrollable, unpredictable, and are erratic. These forces are earthquakes, wars, flood, famines, and any other disasters.

Measurement of secular trend

- The following are the importance methods of measuring secular trend
- 1.Graphic Method
- 2.Semi –average Method
- 3. Moving average Method
- 4.Method of least Squares

- **Graphical Method**
- Construct an x-y coordinate plane/graph
- Plot all constraints on the plane/graph
- Identify the feasible region dictated by the
- constraints
- Identify the optimum solution by plotting a
- series of objective functions over the feasible
- region
- Determine the exact solution values of the
- decision variables and the objective function
- at the optimum solution

Method of Semi Averages

- In this method, we can find the solution of a secular trend. For this, we have to show our time series on graph paper. For example, we can take sales on X-axis and data of production on Y-axis. Now make the original graph by plotting points on graph paper with time and value pairs. After plotting original data we can calculate the trend line. For calculating the trend line, we will calculate semi-average.
- We divide the data into two equal parts with respect to time. And then we plot the arithmetic mean of the sets of values of Y against the center of the relative time span. If the number of observations is even then the division into halves will be done easily.

- **Advantages**
- This method is simple to understand as compare to other methods for measuring the secular trends.
- Everyone who applies this method will get the same result.
- **Disadvantages**
- The method assumes a straight line relationship between the plotted points without considering the fact whether that relationship exists or not.
- If we add more data to the original data then we have to do the complete process again for the new data to get the trend values and the trend line also changes.

Moving Average

In statistics, a moving average is a calculation used to analyze data points by creating a series of averages of different subsets of the full data set. In finance, a moving average (MA) is a stock indicator that is commonly used in technical analysis. The reason for calculating the moving average of a stock is to help smooth out the price data by creating a constantly updated average price.

Moving Average Example

John is a building contractor with a record of a total of 24 single family homes constructed over a 6-year period. Provide John with a 3-year moving average graph.

		Ave
1994	2	NA
1995	5	3
1996	2	3
1997	2	3.67
1998	7	5
1999	6	NA

Illustration – 1:

Calculation of 3 yearly moving average

Years	Sales ('000 units)	Three yearly moving total ('000 units)	Three yearly moving average ('000 units)
1982	55		
1983	47	161	53.67
1984	59	257	85.67
1985	151	289	96.33
1986	79	266	88.67
1987	36	160	53.33
1988	45	153	51
1989	72	200	66.67
1990	83	244	81.33
1991	89	274	91.33
1992	102		

Least Squares Method

- The "least squares" method is a form of mathematical regression analysis used to determine the line of best fit for a set of data, providing a visual demonstration of the relationship between the data points. Each point of data represents the relationship between a known independent variable and an unknown dependent variable.

Method of least squares:

The trend line is represented as: $y_c = a + bx$

The value of a and b can be ascertained by solving the following two normal equations.

$$\Sigma y = Na + b\Sigma x$$

$$\Rightarrow a = \frac{\Sigma y}{N}$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

$$\Rightarrow b = \frac{\Sigma xy}{\Sigma x^2}$$

Illustration - 7

Calculation of trend values by least squares

Year	Production (in tonnes) (y)	Deviation from 1983 (x)	xy	x^2
1980	57	-3	-171	9
1981	64	-2	-128	4
1982	74	-1	-74	1
1983	85	0	0	0
1984	97	1	97	1
1985	104	2	208	4
1986	113	3	339	9
	$\Sigma y = 595$	$\Sigma x = 0$	$\Sigma xy = 308$	$\Sigma x^2 = 28$

$$\Sigma y = Na + b\Sigma x$$

$$595 = 7a + 0$$

Hence, $a = \frac{\Sigma y}{n} = \frac{595}{7} = 85.$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

$$308 = 0 + b(28)$$

Hence, $b = \frac{\Sigma xy}{\Sigma x^2} = \frac{308}{28} = 11.$

$$\Rightarrow Y_c = a + bx$$

$$Y_{1980} = 85 + 11(-3) = 52$$

$y_{1982} = 85 + 11(-1) = 74$

$y_{1983} = 85 + 11(0) = 85$

$y_{1984} = 85 + 11(1) = 96$

$y_{1985} = 85 + 11(2) = 107$

$y_{1986} = 85 + 11(3) = 118$

$y_{1987} = 85 + 11(4) = 129$ units

$y_{1988} = 85 + 11(5) = 140$ units

INTERPOLATION AND EXTERPOLATION

Meaning:

- Interpolation consist in trading a value which lives between two points .
- Interpolation is the"art of reading between the lines of table'-Thile

Definitions:

Hirach defines interpolation as " interpolation is the estimate of a most likely in given conditions. The technique of estimation a past figure is trend as interpolation".

Assumption:

- The variables should not raise and fall over a period of time. It means that the variables should not assume sudden jump or fall period to period.
- The rate of change of figures should be inform from one period to another

UNIT-V

INDEX NUMBER

Meaning:

Index number is a measure of studing the relationship between two variables .taking one variable as a base relationship of the other variable as percentage basis are calculated.

Definition:

According to Croxtan and Cowden, “ index numbers are devices for measuring differences in the magnitude of a group of related variables”.

- Methods of construction of index number:
- 1.Unweighted(simple)
  - Simple Aggregate
  - Simple average of price relations

2. Weighted
  - Weighted Aggregate
  - Weighted average of price relations

Unweighted Index

- An unweighted index is comprised of securities with equal weight within the index. An equivalent dollar amount is invested in each of the index components. For an unweighted stock index, one stock's performance will not have a dramatic effect on the performance of the index as a whole.

2. Simple average of Price relative method:

$$\Rightarrow \frac{P_1 \times 100}{P_0}$$

Where P_1 - denotes price for current year

P_0 - denotes price for base year

Commodity	Price in 1992 P_0	Quantity in 1992 q_0	Price in 1993 P_1	Quantity in 1993 q_1	P_1q_0	P_0q_0	P_1q_1	P_0q_1
A	7	10	9	12	90	70	108	84
B	2	15	10	15	150	120	150	120
C	5	21	7	22	147	105	154	110
D	11	20	12	24	240	220	288	264
E	9	20	11	21	220	180	231	189
					ΣP_1q_0 = 947	ΣP_0q_0 = 895	ΣP_1q_1 = 1031	ΣP_0q_1 = 967

$$P_{01} = \sqrt{\frac{\Sigma P_1q_0}{\Sigma P_0q_0} \times \frac{\Sigma P_1q_1}{\Sigma P_0q_1}} \times 100$$

$$= \sqrt{\frac{947}{895} \times \frac{1031}{967}} \times 100$$

$$= \sqrt{1.201 \times 1.195} \times 100$$

$$= \sqrt{1.4352} \times 100$$

$$= 1.196 \times 100$$

$$P_{01} = 119.6$$

$$P_{10} = \sqrt{\frac{\Sigma P_0q_1}{\Sigma P_1q_1} \times \frac{\Sigma P_0q_0}{\Sigma P_1q_0}} \times 100$$

$$= \sqrt{\frac{862}{1031} \times \frac{895}{947}} \times 100$$

$$= \sqrt{0.837 \times 0.832} \times 100$$

$$= \sqrt{0.696} \times 100$$

$$= 0.834 \times 100$$

TEST OF CONSISTENCY OF INDEX NUMBER

1.Time reversal test:

This test is advocated by prof. Irvin fisher to test the consistency of the index number

$$Po1XP10=1$$

2.Factor reversal test:

This text is also recommended by fisher to test the consistency of index number

$$V=Po1XQo1$$

CHAIN BASE METHOD

- In the fixed index number. The remains the same for all the series of the index . In practice , the base once selected may not be suitable for another period due to various reason like change in economic conditions , the change in the social behaviour of people etc…

steps for the construction of chain indices:

1. Calculate the link relatives, which is equal to $\frac{\text{Current year price}}{\text{Previous year price}} \times 100$

2. Chain index can be calculated through the following

$$\text{Chain index} = \frac{\text{Current year} \times \text{Previous year chain index}}{100}$$

Conversion of chain base index into fixed base index

$$\text{Current years fixed base index (FBI)} = \frac{\text{Current years CBI} \times \text{Previous yr}}{100}$$

CBI - Chain Base Index.

Base shifting:

$$\text{Index number based on new base} = \frac{\text{Current years old index number}}{\text{New base years old index number}} \times$$

Quantity Index Numbers

- To measure the growth and progress of an economy, economists and scientists use many statistical tools. One such very important tool are index numbers. They help reveal the trends and tendencies of the economy and also help in the formulation of economic policies and laws.
- There are broadly three types of index numbers – price index numbers, value index numbers, and quantity index numbers. Let us learn about the latter.

Unweighted Quantity Indices

Weighted Quantity Indices

Unweighted Index: Simple Aggregate Method

Here we do a simple and direct comparison of the aggregate quantities of the current year, with those of the previous year. We express this index number as a percentage. No weights are assigned, it is the simplest calculation. The formula is as follows,

$$Q01=\Sigma Q1\Sigma Q0\times 100$$

Unweighted Index: Simple Average of Quantity Method

this method, we take the aggregate quantities of the current year as a percentage of the quantity of the base year. Then to obtain the index number, we average this percentage figure. So the formula under this method is as follows,

$$Q01=\Sigma Q1\Sigma Q0\times 100\div N$$

Weighted Index: Simple Aggregative Method

There are a few various methods for calculating this index number. We will take a look at some of the most important ones.

1] *Laspeyres Method*

In this method, the base price is taken as the weight. We only use the price of the base year (P0), not the current year. The formula is as follows,

$$Q01=\Sigma Q1P0\Sigma Q0P0\times100$$

2] *Paasche's Method*

Here, the current year price (P1) of the commodity is taken as the weight.

$$Q01=\Sigma Q1P0\Sigma Q0P0\times100$$

Solution:-06

Commodity	Base year (2010) P_0	Base year (2010) q_0	Current year (2020) P_1	Current year (2020) q_1	P_0q_1	P_1q_1	P_0q_0	P_1q_0
Rice	6	15	7	12	72	84	90	105
wheat	4	5	6	4	20	24	20	30
Sugar	7	4	9	3	21	27	28	36
Tea	52	2	55	2	104	110	104	110
					$\sum P_0q_1 = 227$	$\sum P_1q_1 = 245$	$\sum P_0q_0 = 242$	$\sum P_1q_0 = 281$

Laspeyres Method $(P_{01}) = \frac{\sum P_1q_0}{\sum P_0q_0} \times 100$

$= \frac{281}{227} \times 100$

$P_{01} = 123.789$

Paasche's Method $(P_{01}) = \frac{\sum P_1q_1}{\sum P_0q_1} \times 100$

$= \frac{245}{201} \times 100$

$P_{01} = 121.89$

Bowley - Doubish Method $(P_{01}) = \frac{L+P}{2}$

$= \frac{123.79 + 121.89}{2}$

$= \frac{245.68}{2}$

$P_{01} = 122.84$

Fisher's Index Method $(P^F) = \sqrt{L \times P}$

$= \sqrt{123.79 \times 121.89}$

$= \sqrt{15082.7631}$

$P_{01} = 122.84$