

**SUBJECT NAME : APPLIED STATISTICS**

**SUBJECT CODE : CST54**

**UNIT : II**

## UNIT-II Measurement of Seasonal Fluctuation

Seasonal patterns are exhibited by most of the business and economic phenomena and their study is necessitated by the following reasons:

- (i) To isolate the seasonal variations,
- (ii) to determine the effect of seasons on the size of the variable, and,
- (iii) To eliminate them, i.e., to study as to what would be the value of the variable if there were no seasonal swings.

The determination of seasonal effects is of paramount importance in planning

- (i) business efficiency (ii)
- (ii) a production programme.

The isolation and elimination of seasonal factors from the data is necessary to study the effect of cycles.

Obviously for the study of seasonal variation the data must be given for

'parts' of year, viz., monthly or quarterly, weekly, daily or hourly.

Different methods for measuring Seasonal Variations are:

- (i) Method of Simple average.
- (ii) Ratio to trend method
- (iii) Ratio to moving average method
- (iv) Link relative method.

#### (i) Method of simple averages.

This is the simplest of all the methods of measuring seasonality and consists in the following steps:

- (i) Arrange the data by years and months (or quarters if quarterly data are given)
- (ii) Compute the average  $\bar{x}_i$  ( $i = 1, 2, \dots, 12$ ) for the  $i$ th month for all the years.  
(ith month,  $i = 1, 2, \dots, 12$  represents January, February, ..., December respectively.)
- (iii) Compute the average  $\bar{x}$  of the monthly averages  $\bar{x}_{12}$

$$\bar{x} = \frac{1}{12} \sum_{i=1}^{12} \bar{x}_i$$

(iv) Seasonal indices for different months are obtained by expressing monthly averages as percentage of  $\bar{x}$ . Thus,

Seasonal Index for  $i$ th month

$$= \frac{\bar{x}_i}{\bar{x}} \times 100, (i=1, 2, \dots, 12)$$

Note:

1. If instead of monthly average, we use monthly totals for all the years, the result remains the same.

2. Total of seasonal indices is  $12 \times 100 = 1200$  for monthly data and  $4 \times 100 = 400$  for quarterly data.

Merits and Demerits.

This method is based on the basic assumption that the data do not contain any trend and cyclic components and consists in eliminating irregular components by averaging the monthly (or) quarterly values over years.

Since most of the economic time series have trends, these assumptions are

not in general true and as such this method, though simple, is not of much practical utility.

Example: 242 I

The data below give the average quarterly price of a commodity for four years.

Year	1 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter
1990	40.3	44.8	46.0	48.0
1991	50.1	53.1	55.3	57.5
1992	47.2	50.1	52.1	55.2
1993	55.4	59.0	61.6	65.3

Calculate the seasonal variation indices.

Solution:- Assuming that the trend is absent in the above data, the difference in the average of various quarters (if there is any) will be due to seasonal changes.

Computation of Seasonal Indices (5)

Year	1 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter
1990	40.9	42.8	46.0	48.0
1991	50.1	53.1	55.3	57.5
1992	47.2	50.1	52.1	55.2
1993	55.4	59.0	61.6	65.3
Total	193.6	207.0	215.0	226.0
Average	48.25	51.75	53.75	57.0

Seasonal Index	91.57	98.21	102.01	108.12
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The average of averages

$$= \frac{48.25 + 51.75 + 53.75 + 57.0}{4}$$

$$= 52.69$$

Seasonal Index of 1<sup>st</sup> quarter

$$= \frac{48.25}{52.69} \times 100$$

$$= 91.57$$

Seasonal Index for Second quarter

$$= \frac{951.75}{52.69} \times 100$$

$$= 182.4$$

(6)

Seasonal Index for 3rd quarter

$$= \frac{53.75}{52.69} \times 100$$

$$= 102.01$$

Seasonal Index for 4<sup>th</sup> quarter

$$= \frac{57.0}{52.69} \times 100$$

$$= 108.18$$

Example :- use the method of monthly average to determine the monthly indices for the following data of production of commodity for the year 1981, 1982, 1983.

Month	1981	1982	1983	1984
	(Production in tonnes)			(7)
Jan.	12	15	16	
Feb.	11	14	15	
Mar.	10	13	14	
Apr.	14	13	16	
May	15	16	17	
June	15	15	16	
July	16	17	15	
Aug.	10	12	10	
Sept.	10	12	10	
Oct.	12	13	15	
Nov.	15	14	15	
Dec.	15	14	15	

Total:

### Computation of Seasonal Indices.

Month	Production in tonnes			Average	Seasonal Index
	1981	1982	1983		
Jan.	12	15	16	14.33	104.886
Feb.	11	14	15	13.33	97.566
Mar.	10	13	15	12.33	96.247
Apr.	14	16	16	15.33	112.205
May	15	16	16	15.33	112.205
June	15	15	15	15.33	112.205
July	16	17	17	15.66	114.520
Aug.	10	12	16	12.33	109.524
Sept.	11	13	15	12.66	102.662
Oct.	10	12	16	12.33	92.928
Nov.	12	13	10	11.66	78.024
Dec.	15	14	11	12.66	87.532
Total				149.2	100.00
Average				49.7	100.00

	monthly AVERAGE	Seasonal Index
Total	163.95	12.00
Average	13.6625	100

Average of averages

$$\bar{x} = \frac{1}{12} (14.33 + 13.33 + 12.33 + 15.33 + \\ 15.33 + 15.66 + 16.33 + 12.66 + 11.33 \\ (8.66 + 12.00 + 14.66)) \\ = \frac{163.95}{12} \\ = 13.6625$$

Seasonal Index for January

$$= \frac{14.33}{13.6625} \times 100 \\ \approx 104.886$$

Seasonal Index for Feb.

$$= \frac{15.33}{13.6625} \times 100 = 112.566$$

and so on.

### Ratio to trend Method

(9)

This method is an improvement over the simple average method and is based on the assumption that seasonal variation for any given month is constant factor of the trend.

The measurement of seasonal variation by this method consists on the following steps:

(i) Obtain the trend values by the least square method by fitting a mathematical curve, straight line (or) 2nd degree polynomial etc.

(ii) Express the original data as the percentage of the trend values. Assuming the multiplicative model, these percentages will contain the Seasonal Cyclic and irregular Components.

(iii) The cyclic and irregular <sup>(10)</sup> components are then wiped out by averaging the percentages for different months (quarters) if the data are monthly (quarterly), thus leaving us with indices of seasonal variation.

Either arithmetic mean or median can be used for averaging, but median is preferred to arithmetic mean since the latter gives undue weightage to extreme values which are not primarily due to seasonal swings.

(iv) Finally, these indices, obtained in step (iii), are adjusted to a total of 1200 for monthly data or 400 for quarterly data by multiplying them throughout by a constant  $k$  given by.

$$k = \frac{1200}{\text{total of the indices}} \quad \text{and}$$

$$k = \frac{400}{\text{total of the indices}}$$

for monthly and quarterly data respectively.

(11) 18

### Merits and Demerits:

Since this method attempts at ironing out the cyclical or irregular components by the process of averaging, the purpose will be accomplished only if the cyclical variation are known to be absent or they are not so pronounced even if present.

On the other hand, if the series exhibits pronounced cyclical swings, the trend values obtained by the least square method can never follow the actual data as closely as n-month moving average and as such the seasonal indices obtained by 'ratio to trend' method are liable to be more biased than those obtained by 'ratio to moving average' method.

The obvious advantage of this method over the moving average method lies in the fact that 'ratio to trend'

can be obtained for each month for which the data are available and  $\frac{12}{12}$ . Such, unlike the ratio to moving average method, there is no loss of data.

Note:

The calculation are simplified to great extent by first fitting a trend equation to the yearly total (or averages) and then obtaining the monthly or (quarterly) trend values by a suitable modification of the trend equation.

Example:

Calculate Seasonal Variation for the following of sales in thousands Rs. of a firm by the Ratio to Trend method.

Year	1 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter
1979	30	40	36	34
1980	54	52	50	44
1981	40	53	54	42
1982	52	76	68	62
1975	30	92	50	52

Q1 First of all determine the trend values for the yearly average (A) by fitting a linear trend by the method of least squares.

Year	Yearly total (x)	Yearly average (y)	$U = x - 1972$	$UV$	$U^2$	Trend value
1979	140	35	-2	-70	4	32
1980	120	45	-1	-45	1	44
1981	200	50	0	0	0	56
1982	260	65	1	65	1	68
1983	340	85	2	170	4	80
Total		280	0	120	10	

for the line  $y = a + bu$ , the normal equations for estimating  $a$  and  $b$  are

$$\sum y = na + b \sum u$$

$$\sum uv = a \sum u + b \sum u^2$$

$$a = \frac{\sum y}{n} = \frac{280}{5} \Rightarrow 56$$

$$b = \frac{\sum uv}{\sum u^2} = \frac{120}{10} \Rightarrow 12$$

∴ Trend line is  $y = 56 + 12u$

$$u = -2 \Rightarrow y = 56 - 24 = 32$$

$$u = -1 \Rightarrow y = 56 - 12 = 44$$

Only other trend values is given in the above table  
can be obtained

(14)

Yearly increment into trend values  $30 = 12$

Quarterly increment  $= 12/4 = 3$

Next, we the quarterly trend values.

For 1979 the trend value for the middle quarter, i.e.,  
half of second quarter and half of third quarter  
is 32 and. Since the quarterly increment involves 3.

We obtain the trend values for the second  
and third quarters of 1979 as  $32+1.5$  and  $32+1.5+0.5$ ,  
30.5 and 33.5 respectively and consequently the trend  
values for the first quarter is  $30.5 - 3 = 27.5$  and  
4th quarter is  $33.5 + 3 = 36.5$ .

Now we can get the trend values for the  
years as given in the following table

#### Calculation for seasonal Variations.

##### Trend values

Year I Quart II Quart III Quart IV Quart

1979 27.5 30.5 33.5 36.5

1980 39.5 42.5 45.5 48.5

1981 51.5 54.5 57.5 60.5

1982 63.5 66.5 69.5 72.5

1983 75.5 78.5 81.5 84.5

### Ratio to Moving Average method. 15

As pointed out earlier moving average eliminates periodic movements if the extent (period of moving average) is equal to the period of the oscillating movements sought to be eliminated.

Thus for a monthly data a 12 month moving average should completely eliminate the seasonal movements if they are of constant pattern and intensity. The method of getting seasonal indices by moving average involves the following steps.

(i) Calculate the centred 12 month moving average data. These moving average values will estimates of the combined effects of trend and cyclic variations.

(ii) Express the original data (except for 6 months in the beginning and 6 months at the end) as percentages of the centred moving average values using multiplicative model, these percentages would then represent the seasonal and irregular components.

(v) The Preliminary Seasonal Indices ~~are 16~~  
has obtained by eliminating the irregular  
or random component by averaging  
these percentages. either arithmetic mean  
or median (preferably median) can be used  
for averaging.

(vi) The sum of these indices = 8 (Say)  
will not, & in general, be 1200. Finally an  
adjustment is done to make the sum of the  
indices 1200 by multiplying throughout by a  
constant factor =  $1200/8$ , i.e., by expressing  
the Preliminary Seasonal Indices as the  
percentage of their arithmetic mean. The  
resultant gives the desired indices of  
Seasonal Variations.

Merits and Demerits:

of all the methods of measuring  
Seasonal Variations, the ratio to the moving  
Average Method is the most satisfactory,  
flexible and widely used method. These  
indices do not fluctuate so much as the  
indices by the ratio to trend method.

This method does not completely utilize the data, e.g., in the case of 12-month moving average seasonal indices cannot be obtained for the first 6 months and for the last 6 months.

Note: 1. Specific Seasonal Index 2. Typical Seasonal Index:

The seasonal indices for each month(quarter) of different years are also known as specific seasonal and the averages of specific seasonal for each month (quarter) for a number of years are termed as typical seasonals.

## 2. Additive Model:

If we use additive model of the time series, then the method of moving averages for computing seasonal indices involves the following steps.

(i) Obtain 12-month moving average values. These will contain trend and cyclic components, i.e., they will represent  $(T+C)$

(ii) Trend eliminated values are obtained on subtracting these moving average

values from the given time series values) 18  
to give:

$U_t$  - Moving Average Value =

$$(T+S+C+I) - (T+C) = S+I$$

(iii) Irregular components b. eliminated  
on averaging those ( $S+I$ ) values for each  
month over different years and we get the  
preliminary indices for each month.

(iv) Sum of the indices should be zero.

In case it is not so, the preliminary  
indices in Step (iii) are adjusted to a total  
of zero by subtracting from each of them  
a constant factor.

$$\frac{k}{12} \quad [\text{sum of monthly seasonal indices}]$$

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Example:

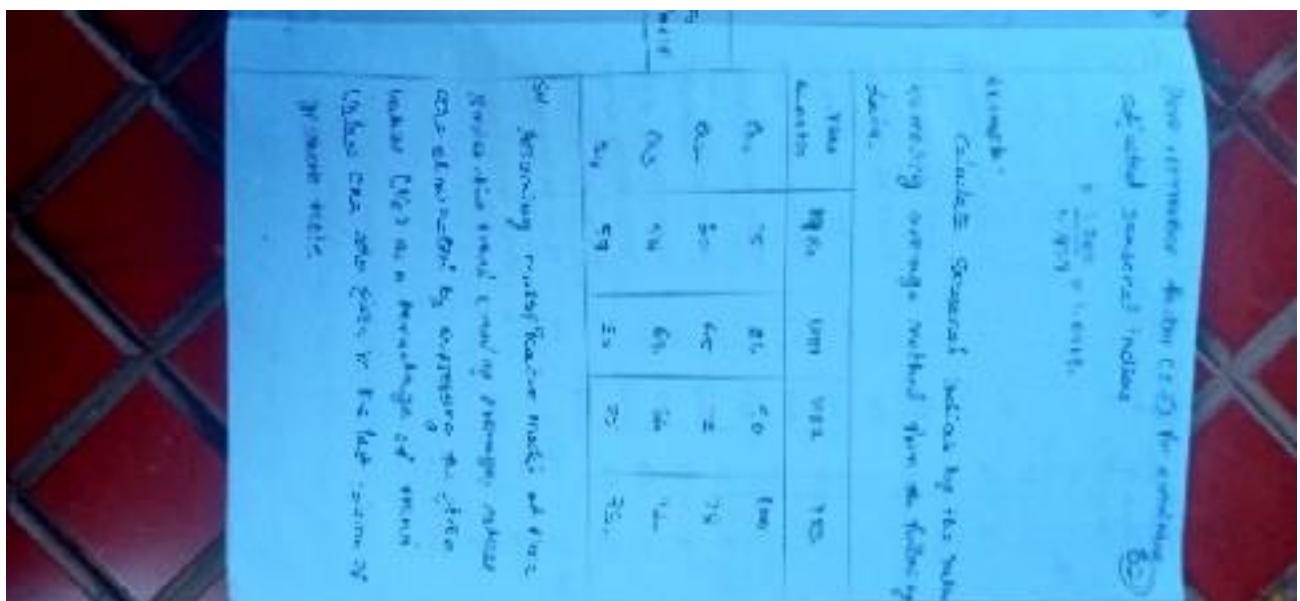
Apply ratio to moving average method to ascertain seasonal indices from the following data.

Year-end month 1981	No. of persons Visiting a place of interest	Year-end month 1982	No. of persons Visiting a place	Year-end month 1983	No. of persons Visiting a place
Jan	90	Jan	100	Jan	110
Feb	85	Feb	89	Feb	93
Mar	70	Mar	74	Mar	78
Apr	60	Apr	62	Apr	66
May	55	May	55	May	58
June	45	June	47	June	40
July	50	July	30	July	35
Aug	40	Aug	43	Aug	45
Sep	70	Sep	65	Sep	72
Oct	120	Oct	127	Oct	130
Nov	115	Nov	118	Nov	118
Dec	118	Dec	120	Dec	124

Year & month	No. of persons visiting a place of interest (1)	12-Point moving total (2)	12 Point	12 Point M.A. with 3 (3)	12 Point M.A. centered (5)	Rabbi M.A. (with 3) (6)
			12			
1981	Jan	90				2.0
	Feb	85				
	Mar	70				
	Apr	60				
	May	65				
	June	45				
	July	30				
	Aug	40	89.9	74.63	75.3	39.8
	Sept	70	90.8	75.67	75.8	52.9
	Oct	120	91.2	76.00	76.2	91.4
	Nov	115	91.6	76.33	76.4	157.1
	Dec	98	91.8	76.50	76.5	158.3
1982	Jan	100	92.0	76.66	76.6	154.6
	Feb	89	92.0	76.66	76.7	150.9
	Mar	74	92.3	76.91	76.8	55.0
	Apr	62	91.8	76.50	76.7	96.5
	May	55	92.5	77.03	77.2	71.2
	June	47	92.6	77.33	77.4	67
	July	30	93.0	77.50	77.9	38.7
	Aug	43	94.0	78.33	78.4	54.8
	Sept	65	94.4	78.66	78.6	82.5
	Oct	127	94.8	79.00	79.2	116.4
	Nov	118	95.2	79.33	79.4	148.4
	Dec	120	95.5	79.57	79.5	161.5

Jan	45			79.2	132.9
Feb	95	95.3	79.41	79.3	117.8
Mar	75	95.5	79.52	79.9	97.6
Apr	66	96.2	80.16	80.3	82.2
May	58	96.5	80.41	80.4	72.1
June	60	96.6	80.41	81.75	69.6
July	35				
Aug	45				
Sep	72				
Oct	130				
Nov	114				
Dec	124				

Month	1981	1982	1983	Seasonal Indices Adjusted	Seasonal Index (Seasonal Index x CP)
				(Arithmetic mean)	
Jan	130.4	138.9	134.7	135.0	
Feb	115.9	117.0	116.5	116.7	
Mar	96.5	97.6	97.1	97.3	
Apr	80.7	82.2	81.5	81.7	
May	71.2	72.1	71.7	71.8	
June	60.7	49.6	57.2	57.5	
July	39.8	38.5	39.2	39.3	
Aug	52.8	54.8	53.2	53.9	
Sep	91.9	82.5	87.1	87.5	
Oct	157.1	160.4	158.7	159.1	
Nov	150.3	148.4	149.4	149.7	
Dec	154.0	151.5	152.7	153.0	
Total				1,197.7	1280x1



The Committee of the C.C. for Standardized Supplies - India

S. K. N. & S. R. I. T.

Subject: General notice by the Indian Army Supply Department regarding shoes sent from the following factories:-

Regt	Shoes	Boots	Gloves	Trousers
Regt	25	25	25	100
Regt	25	25	25	75
Regt	25	25	25	100

Observing results of earlier trials and also  
considering the present condition of supplies  
of shoes and boots to the Indian Army, it is  
noted that the following are required:-  
Indian Regt. 25, 25, 25, 100  
Orissa Rifles 25, 25, 25, 75  
Bengal Rifles 25, 25, 25, 100  
W.M.R. 25, 25, 25, 100

Year-	Price	Quarterly Moving Total	Sum of two quarters	Quarterly mean	Ratio to moving avg.	U <sub>t</sub> - MA
Quarter	U <sub>t</sub>	(2)	(4)	(5) = (3) - (2)	(6) = (2) / (5)	(7)
(1)	(3)					
1980	I	75				
	II	60				
	III	54	248	507	63.375	89.250 - 9.375
	IV	59	259	523	65.375	90.2456 - 6.375
1981	I	86				
	II	65	273	537	67.125	102.1192 - 18.375
	III	63	294	567	76.875	91.9108 - 5.875
	IV	80	293	592	74.000	85.1357 - 11.000
1982	I	90				
	II	72	308	617	76.625	117.4553 - 15.625
	III	66	313	621	75.625	92.7536 - 5.625
	IV	85	323	636	79.500	85.0149 - 13.500
1983	I	100				
	II	78	335	649	83.000	100.4819 - 17.500
	III	72	343	672	84.750	92.0307 - 6.750
	IV	93				

Year	Trend eliminated values				(24)
	1 Qtr	2 Qtr	3 Qtr	4 Qtr	
1980	-	-	89.2071	90.2475	
1981	122.192	91.7108	85.1851	106.1366	
1982	117.4551	92.7556	83.0187	104.2945	
1983	120.4819	92.0354			
Total	366.0562	276.4998	253.341	300.6770	
Average (S.I)	122.027	92.1666	84.4537	100.226	Total = 398.865
Adjusted Seasonal Index	122.3662	92.0246	84.6902	100.5046	$\Rightarrow$ Total $399.985 \approx 400$

The seasonal indices obtained as average (A.M) above are adjusted to a total 400, by multiplying each of them by a constant factor.

$$k = \frac{400}{\text{Sum of Seasonal Indices}} \\ = 400 / 398.865 = 1.0022.$$

If we assume additive model of the time series, then the trend eliminated values (Short-term and irregular fluctuations)

are obtained on Subtracting the trend (M.A.)  
Values from the given time series values <sup>(S.E)</sup>  
i.e., by the formula.

Short-term fluctuations =  $U_t - (\text{M.A. Values})$ ,  
SI, and are given in the last column of  
the first table. These values are then used  
to obtain the Seasonal indices as explained  
in the following table.

#### Computation of Seasonal indices.

Year	I	Q	S	T	U
1980	-	-	-9.375	-6.375	
1981	48.275	-5.875	-8.000	4.625	
1982	13.375	-5.625	-13.500	3.500	
1983	17.000	-6.750	-	-	
Total	49.250	-18.250	-33.875	1.750	
Average (S.I.)	16.417	-6.083	-11.292	0.583	
Adjusted Seasonal Indices	16.53	-5.989	-11.192	0.677	

### Sum of Seasonal Indices S.I

A) 25

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$$= 16.417 - 6.025 - 11.292 + 0.583$$

$$= 0.375$$

(a) =

f

ad

and

Since the sum is not zero, these indices are adjusted to a total of zero by subtracting from each of them a constant factor.

$$k = \frac{\text{Sum of indices}}{4}$$

$$= \frac{-0.375}{4} = -0.094$$

①

Adjusted S.I. for S.E.I 1<sup>st</sup> Qtr = 16.417. Now, we can obtain the adjusted seasonal indices for the remaining quarters, which are given in the last row of the above table.

### Link Relative Method:

This method, also known as Pearson's method is based on averaging the link relatives. Link relative is the value of one season expressed as a percentage of the preceding season. Here the word "Season" refers to time period. It would mean monthly for monthly data, quarter for quarterly

data etc. Thus: for monthly data:

(27)

Link relative for any month

$$= \frac{\text{Current month's figure}}{\text{Previous month's figure}} \times 100$$

The steps involved in this method may be summed up as follows.

- (i) Translate the original data into link relatives (L.R.) as explained above.
- (ii) As in the case of ratio to trend method, average the link relatives for each month (quarter) if the data are monthly (quarterly). Mean or Median may be used for averaging.
- (iii) Convert the average (Mean or Median) link relative into chain relatives on the base of the first season. Chain relative (C.R.) for any season is obtained by multiplying the link relative of that season by the chain relative of the preceding season and dividing by 100. Thus for monthly data, the chain

relative for first season (month), i.e.  $\text{CR}_{23}$   
for Jan, is taken be 100.

$$\text{C.R. for February} = \frac{\text{L.R. of Feb} \times \text{C.R. of Jan}}{100}$$

$\therefore (\text{C.R. of Jan} = 100)$

$$= \text{L.R. of Feb}$$

$$\text{C.R. for March} = \frac{\text{L.R. of March} \times \text{C.R. for Feb}}{100}$$

$$\text{C.R. for December} = \frac{\text{L.R. of Dec} \times \text{C.R. for Nov}}{100}$$

Now, by taking this December values as a base, a new chain relative for January can be obtained as:

$$\frac{\text{L.R. of January} \times \text{C.R. for December}}{100}$$

usually, this will not be 100 due to trend and so we have to adjust the chain relatives for trend.

(iii) This adjustment is done by subtracting a correction factor from each chain relative. If we write,

$d = \frac{1}{12}$  [Second C.N.W.S.C.R. for January-10]  
then, assuming linear trend, the correction factor for February, March, ... December  $4d, 3d, \dots, 1d$ , respectively.

(iv) Finally, adjust the corrected chain relatives to total 1200 by expressing the corrected chain relatives as percentages of their arithmetic mean. The resultant gives the adjusted monthly indices of seasonal variations.

#### Merits and Demerits.

(i) The link relatives averaged together contain both the trend and cyclic components. Although the trend is subsequently eliminated by applying correction, the method is effective only if the growth is of constant amount or constant rate.

(ii) Though not so simple are the moving average method, or so readily adaptable as other to the construction of some or more complex types of seasonal movements, the actual computation of

link relative method are much less intensive.

(iii) This method utilizes data more completely than moving average method. There is only one link relative while a 12-month moving average results in cut of six months at each end.

example: The data below gives the average quarterly prices of a commodity for the five years. Calculate the seasonal variation indices by the method of link relatives.

Year	1979	1980	1981	1982	1983
Quarter					
I	30	35	31	31	34
II	26	28	29	31	36
III	22	22	28	25	26
IV	31	36	32	35	33

Calculation for seasonal indices by the method  
of Link relatives

(3)

Year	Link relatives			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
1979	-	96.7	104.6	110.9
1980	112.9	80.0	118.6	165.6
1981	86.1	93.5	96.6	114.3
1982	96.9	100.0	88.7	140.0
1983	97.1	106.9	72.2	126.9
Total	393.4	466.1	412.7	685.7
A.M. (Average)	98.25	93.22	82.54	137.14
Chain relatives	100	$\frac{100 \times 93.22}{100} = 93.22$	$\frac{93.22 \times 82.54}{100} = 76.95$	$\frac{76.95 \times 137.14}{100} = 105.5$
Adjusted chain relatives	100	92.345	75.2	102.775
Seasonal indices	108.02	99.75	81.23	111.00

Explanation of steps:

(32)

The second chain relative for the first

$$\text{Quarter} = \frac{105.4 \times 99.5}{100}$$

$$= 103.5$$

Correction factor  $d = \frac{1}{4}(103.5 - 100.0)$

$$= 3.5/4 = 0.875$$

Adjusted chain relatives are obtained by  
Subtracting  $0.875, 2 \times 0.875, 3 \times 0.875$  from  
the chain relatives of second, third and  
fourth quarter respectively.

Average of adjusted chain relatives

$$= \frac{100 + 92.342 + 75.20 + 102.77}{4}$$

$$= 92.58$$

Seasonal variation Index for any quarter

$$= \frac{\text{adjusted CR}}{92.58} \times 100$$

Seasonal indices have been obtained in  
the above table.

## De-Seasonalisation of data.

(33)

The objective of studying Seasonal Variations is

- (i) To measure them and
- (ii) To eliminate them from the given series.

Elimination of the seasonal effects from the given values is termed as de-seasonal of the data.

It helps us to adjust the given time series for seasonal variations, thus leaving us with trend component, cyclic and irregular movements. Assuming multiplicative model of the time series, the de-Seasonalised values are obtained on dividing the given values by the corresponding indices of Seasonal variation.

$$\text{Deseasonalised data} = \frac{U_t}{S} = \frac{TCSI}{S} = TCI$$

Deseasonalised is specially needed for the study of cyclic component. It also helps businessmen and management executives for planning future production programmes, for forecasting and managerial control.

Remark:

(34)

In case of absolute seasonal variation, the deseasonalized values are obtained on subtracting the seasonal variations from the given values. Thus

$$\begin{aligned}\text{De-seasonalised data} &= U_t - S \\ &= T + C + I\end{aligned}$$

Example:

A company estimates its sales for a particular year to be Rs. 24,00,000. The seasonal indices for sales are as follows.

Month	Seasonal Index
Jan	75
Feb	80
Mar	98
April	128
May	137
June	119
July	102
Aug	104
Sep	100
Oct	102
Nov	82
Dec	73

using the information, calculate estimates of monthly sales of the company (Assume that there is no trend) (35)

Sol Seasonal indices are usually expressed as percentages and it may be verified that the total of all the seasonal indices is 1200.

$$\text{Seasonal effect} = \text{Seasonal Index} \times 100$$

The Yearly Sales being Rs 24,00,000, the estimated monthly sales for a specified month will be

$$\text{Rs. } 2,00,000 \times \text{Seasonal effect}$$

#### Budget estimates of Monthly Sales

Month (1)	Seasonal Index (2)	Seasonal Effect (Y = (2) ÷ 100)	Estimated Sales(Rs. lakh) (C4) = (= 1(3) × 2)
Jan	95	95/100 = 0.95	0.95 × 2 = 1.90
Feb	80	80/100 = 0.80	0.80 × 2 = 1.60
Mar	98	0.98	1.96
Ap	12.8	1.28	2.56
May	13.7	1.37	2.74
Ju	11.4	1.14	2.38
July	10.2	1.02	2.04
Aug	10.4	1.04	2.08
Sep	10.0	1.00	2.00
OCT	10.2	1.02	2.04
NOV	82	0.82	1.64
Dec	73	0.73	1.46
Total	1200	12.00	24.00

Example:

(36)

The Seasonal Indices of the Sales of  
readymade garments of a particular type  
in a certain store are given below.

Quarter	Seasonal Index
Jan-March	98
April - June	89
July - Sept	82
OCT - Dec	130

If the total Sales in the first quarter  
of the year be worth Rs. 10,000 determine  
how much coorth of garments of this type  
should be kept in stock by the store to  
meet the demand in each of the remaining  
quarters.

Sol. We are given that the total sales  
in the first quarter are worth Rs. 10000  
and since the seasonal index for the first  
quarter is 98. the normal quarterly sales

Sales  $\div$  seasonal effect

$$= 10,000 \div \frac{98}{100}$$

$$= \text{Rs. } 10,204.08$$

On the basis of quarterly sales, the estimated worth of garments in store for the remaining quarters was as follows.

Quarter	Seasonal Index	Seasonal Effect	Estimated Sales (Rs)
II	89	0.89	$10204 \times 0.89 = 9081.63$
III	82	0.82	$10204 \times 0.82 = 8367.35$
IV	130	1.30	$10204 \times 1.30 = 13265.20$

Example:

On the basis of monthly sales (in million rupees) of a certain commodity for a certain number of years, the following calculations were made.

$$\text{Trend : } Y = 25.74 + 0.45t$$

where origin is at January 1982,  $t$  = time unit (one month), and  $Y$  = monthly sales.

Months : Jan Feb Mar Apr May June

Seasonal Index	79	76	95	98	106	97
	July	Aug	Sep	Oct	Nov	Dec

Seasonal Index	86	89	103	122	113	136
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Estimate the monthly sales for 1982.

Sol.

(29)

The trend values for various months of 1982 are obtained from the equation by putting  $t=1, 2, \dots, 12$  respectively.

Calculation for trend values of monthly sales for 1982.

Month	$t$	Trend Values $y = 25.74 + 45t$
Jan	1	$y = 25.74 + 45(1) = 26.19$
Feb	2	$y = 25.74 + 45(2) = 26.64$
Mar	3	$y = 25.74 + 45(3) = 27.09$
April	4	$y = 25.74 + 45(4) = 27.54$
May	5	$y = 25.74 + 45(5) = 27.99$
Jun	6	$y = 25.74 + 45(6) = 28.44$
July	7	$y = 25.74 + 45(7) = 28.89$ 29.34
Aug	8	29.79
Sep	9	30.24
Oct	10	30.69
Nov	11	31.14
Dec	12	

The monthly sales ( $U_t$ ) are now obtained  
on multiplying trend values  $T$  by the  $S_t^{(3)}$   
Seasonal effects ( $S$ ), i.e.,  $U_t = T \times S$

Calculation of estimated monthly Sales  
for 1982.

Month	Trend Values ( $T$ )	Seasonal effect ( $S$ )	Estimated Sales $U_t$ (million Rs)
Jan	26.19	0.79	20.690
Feb	26.64	0.76	20.246
Mar	28.09	0.95	25.795
Apr	27.454	0.98	26.989
May	27.99	1.06	26.669
June	28.44	0.97	24.345
July	28.89	0.86	26.113
Aug	29.34	0.89	30.684
Sep	29.79	0.03	36.840
Oct	30.24	1.22	36.840
Nov	30.69	1.13	34.680
Dec	31.14	1.36	42.350