

# 1. Introduction

Welcome to the series of E-learning modules on measurement of seasonal variations by the method of ratio to trend.

By the end of this session, you will be able to

- Explain the measurement of seasonal variation by using the following methods :
  1. Simple average
  2. Ratio to moving average method
  3. Link relative method
  4. Selecting the right period
  5. Selecting the period for computing seasonal indices
  6. Average in computing seasonal indices
  7. Eliminating seasonal influences
  8. Uses & limitation of seasonal index

## Introduction

Seasonal variations can be attributed to periodic movements in business activity. Such activities can be predicted accurately. However, any business is impacted by seasonal changes but the degree of impact varies. Seasonal does not necessarily align to the different seasons in a year but to certain kind of variations that are periodic in nature and where the cycles repeat.

Most of the phenomena in economic and business activities show seasonal patterns. When data are expressed annually there is no seasonal variation. However, monthly or quarterly data frequently exhibit strong seasonal movements and considerable interest attaches to devising a pattern of average seasonal variation.

For example, if we observe the sales of a book-seller we find that for the quarter July-September (when most of the students purchase books), sales are maximum. If we know by how much the sales of this quarter are usually above or below the previous quarter for seasonal reasons, we shall be able to answer a very basic question, namely, was this due an underlying upward tendency or simply because this quarter is usually seasonally higher than the previous quarter.

In order to analyse the seasonal variation it is necessary to assume that the seasonal pattern is super imposed on a series of values and is independent of these in the sense that the same pattern is super imposed on a series irrespective of the level of the series.

Before attempting to measure seasonal variations, certain preliminary decisions must be made. For example, it is necessary to decide whether weekly quarterly or monthly indexes are required. This will be decided in the light of the nature of problem and the type of data available.

## 2. Seasonal Index and Simple Average - Meaning and Examples

To obtain the statistical description of a pattern of seasonal variation it will be desirable to first free the data from the effects of the trend cycles and irregular variations. Once these components have been eliminated we can calculate in index form the measure of seasonal variations which is usually referred to as a seasonal index. Thus, the measures of seasonal variations are called Seasonal Indexes.

For monthly data, a seasonal index consists of twelve numbers, one for each month of a year or number of years that has taken place typically in each month. Thus, the seasonal index may be specific or typical.

A specific seasonal index refers to the seasonal changes during a particular year. A typical seasonal index is obtained by averaging a number of specific seasonal. It is thus a generalized expression of seasonal variations for a series.

Seasonal indices are given as a percentage of their average, i.e. each month is represented by a figure, expressing it as a percentage of the average month. For example If a seasonal index for January is 75, it means that for the month of January, sales orders or purchases, whatever the data happens to be, are 75% of those of the average month.

There are several methods of measuring seasonal variations; however the most popular amongst them used in practice are Method of Simple Average, Ratio to Trend method, Ratio to Moving Average method and Link Relative method.

Method of Simple Average: this is the simplest method of obtaining the seasonal index. The following steps are followed for calculating the index.

- Arrange the unadjusted data by years and months (Quarters if quarterly data are given)
- Find the totals of each month
- Divide each total by the number of Years for which the data are given
- Obtain an average of monthly averages by dividing the total of monthly averages by 12
- Taking the average of monthly averages as 100, compute the percentages of various monthly averages

Simple Average: Seasonal index for a month is equal to monthly average divided by average of monthly average into 100.

If, instead of monthly data, we are given weekly or quarterly data, we will compute the weekly or quarterly averages by following the same procedures as explained above.

Merits of simple average method:

This method is the simplest of all the methods of measuring seasonality. Most economic series have trends and therefore the seasonal index computed by this method is actually an index of trends and seasonal. In its simplest form this method serves the purpose where no

definite trend exists.

Limitations of simple average method:

It is not a very good method as it assumes that there is no trend component in the series. Furthermore, the effects of cycles on the original values may or may not be eliminated by the averaging process as this depends on the duration of the cycles and the term of the averages.

# 3. Ratio To Trend Method

Ratio to Trend method: This is a method of calculating a seasonal index assuming that seasonal variations for a given month are a constant fraction of trend. It is also known as the Percentage to Trend method. It is a relatively simple method and an improvement over the method of simple averages.

The ratio to trend method presumably isolates the seasonal factor. Trend is eliminated when the ratios are computed.

(S into C into I ) divided by T is equal to S into C into I

Where,

S = seasonal variation

C= cyclical variation

I = irregular variation

T = trend

Random elements are supposed to disappear when the ratios are averaged. A careful selection of the period of years used in the computation is expected to cause the influence of prosperity or depression to offset each other and thus remove the cycles. For series that are not subjected to pronounced cyclical or random influences and for which trend can be computed accurately this method may suffice.

The steps in the computation of seasonal Index by this method are

1. Trend values are obtained by applying the method of Least Square.
2. Divide the original data, month by month by the corresponding trend values and to multiply these ratios by 100. The values so obtained are now free from Trend and the problem that remains is to free them also of irregular and cyclical movements.
3. In order to free the values from irregular and cyclical movements, the figures given for various years for January, February, etc are averaged for any one of the usual measures of central values (Median or Mean). If the data are examined month by month, it is sometimes possible to describe a definite cause for high or low values.
4. When such causes are found to be associated with irregular variations like bad weather, earthquake, famine, etc they may be cast out and the mean of the remaining items is referred to as a Modified mean.
5. As the scrutiny of the data requires considerable knowledge of prevailing conditions and to a large extent subjective it is often described to use the median which is not generally affected by very high or low values.
6. The seasonal index for each month is expressed as percentages of the average months. The sum of 12 values must equal 1200 or 100 %. If it does not, an adjustment is made by multiplying each index by a suitable factor which gives the final seasonal index.

Merits of ratio to trend method:

- Compared with the method of monthly averages, this method is certainly a more logical procedure for measuring seasonal variations
- It has an advantage over the moving average procedures as it has a ratio to trend value for each month for which the data are available. There is no loss of data in the

case of moving averages. This is a distinct advantage when the period covered by time series is very short

- It is simple to compute and easy to understand

Limitations of ratio to trend method:

1. Main defect of this method is that, if there are pronounced cyclical swings in the series, the trend whether straight line or curve, can never follow the actual data
2. A seasonal index computed by the ratio to moving average method maybe less biased than the one calculated by the ratio to the Trend method

## 4. Ratio to Moving Average and Link Relative Methods

Ratio to Moving Average Method: This is also known as the percentage of moving averages and is the most widely method of measuring seasonal variations. The steps necessary for determining seasonal pattern by this method are:

- Eliminate seasonality from the data by ironing out from the original data. Since seasonal variations recur every year at a time span of 12 months, the centred 12 month moving average tends to eliminate these fluctuations.
- In case of quarterly data, data are centred 4 quarter moving average must be used. The centred 12 month moving average, which aims to eliminate the seasonal and irregular fluctuations, represents the remaining elements of the original data namely, Trend and Cycles. Thus the centred 12 month moving average approximates Trend and Cycles.
- Express the original data for each month as percentage of the Centered 12 month moving average corresponding to it.
- Divide each monthly item of the original data by the corresponding 12 month moving average and list the quotients as percent of moving average, which succeeds in eliminating the disturbances of trend and cycles from the original data.
- By averaging these percentages for a given month, the irregular factors tend to cancel out and the average itself reflects the seasonal influence alone.
- The purpose of this step is to average, and in the process of averaging, to eliminate the irregular factor. We assume that the relatively high or extremely low values of the seasonal relatives for any month are caused by irregular factors.
- The elimination of extremes may be achieved while we are averaging all months alike. This is done by using an appropriate type of average. The median is the appropriate extreme. Thus by using the median as an average, we can obtain the typical seasonal relative for each month.
- Sometimes modified means are also used as an average for each month. Extreme values are omitted before the arithmetic mean is taken. For example in an array of seasonal relatives for every month only the arithmetic mean of the seasonal relatives is taken dropping the values at one or both ends.
- The means are preliminary seasonal indexes and should average 100% (or a total of 1200 for 12 months). If the total is not equal to 1200 (100%), an adjustment is made to eliminate the discrepancy. Adjustment consists of multiplying average of each month in step 4 by 1200 by total modified mean for 12 months. If a seasonal index thus obtained aggregates more than 1200 then original data adjusted in terms of it will total less than the adjusted original data. If the seasonal index totals less than 1200, the opposite would be true.

- Main reason to adopt this method is that the 12-month moving average can be considered to represent the influence of cycle and trend (C into T). If the actual value for any month is divided by the 12-month moving average centred to that, the month cycle and the trends are moved. It can be represented by the following equation: Trend into seasonal into cyclical into irregular variation divided by trend into cyclical is equal to seasonal plus irregular variation.
- Thus the ratio to the moving average represents irregular and seasonal influences. If the ratios for each work over a period of years are averaged, most random influences will be eliminated. Hence the resultant expression can be represented as seasonal into irregular variation divided by irregular variation is equal to seasonal variation

Merits of Ratio to Moving Average method:

- i. Ratio to Moving average is a satisfactory and widely used method in practice.
- ii. Index obtained by this method is stable as the index is based on straight line trend
- iii. Index ratios are representative of the data from which they are obtained than in case of Ratio-to-Trend method
- iv. Ratio-to-Moving Average allows greater flexibility
- v. Mathematical methods of avoiding effects of business cycle are not required

Limitations of Ratio to Moving Average Method :

- i. Main defect of this method is that, if there are pronounced cyclical swings in the series, the trend whether straight line or curve, can never follow the actual data
- ii. A seasonal index computed by the ratio to moving average method maybe less biased than the one calculated by the ratio to the Trend method

Link Relative Method:

This is considered to be one of the most difficult methods. The following steps are taken to calculate the seasonal variations indices:

Step 1: Calculate the link relatives of the seasonal figures by dividing the figure of each season by the figure of immediately preceding season and dividing by 100. The percentage such obtained is called link relatives.

Step 2: Calculate the average of the link relatives for each season by taking the arithmetic average or the median. By taking arithmetic average gives undue weight to extreme cases which are not due to seasonal influences.

Step 3: Convert these averages into chain relatives on the base of the first season.

Step 4: Calculate the chain relatives of the first season on the base of the last season. The difference between the chain relative of the first season by this method and the chain relative calculated by the previous method will be due to the effect of long term changes. Hence it is important to correct these chain relatives follows.

Step 5: To correct the differences in the chain relatives, the chain relative of the first season calculated by the first method is deducted from the chain relative of the first season calculated by the second method. The difference thus obtained is divided by the total number of seasons. The result thus obtained is multiplied by 1, 2, 3... and then deducted respectively

from the chain relative of the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> etc....Seasons. Thus we obtain the corrected chain relatives.

Step 6: Express the corrected chain relatives as percentages of their averages. These provide the required seasonal indices by the method of link relatives.



# 5. Selection of the Right Method

Selection of the right method:

We have discussed 4 methods of measuring seasonal variations. However it is important for us to know which method to use and when. The choice of a particular method depends on the nature of the data and object of investigation to be conducted.

Simplest of all the methods is the Method of Monthly Averages; however this assumes that there is no trend component in time series. Hence it can be used only if seasonal rhythm dominates the data and trend and cycles are negligible.

Method of Link Relatives, though popular earlier, is not a popular choice now due to the limitations and disadvantages outlined earlier.

Ratio-to-Moving Average outweighs Ratio-to-Trend method due to the various advantages, flexibility and coverage of all aspects of the data and variations that makes it the popular choice amongst the statisticians to adopt this method.

Selecting the Period in computing Seasonal Indices:

It is important to take into consideration the number of years that are used for arriving at seasonal index since using a short period is affected by conditions prevailing during one phase of the business cycle or random influences.

- i. The period should encompass at least one or more business cycles. However it is advisable to have several business cycles for us to arrive at a more accurate seasonal index.
- ii. Using a longer span of years ensures that the effect of irregular and cyclical forces on the data are minimized or cancelled out. Based on the practical experience a minimum period of 10 years is considered optimal to arrive at a reasonably accurate season index.
- iii. It is extremely important to consider the fact to have the period begin and end at the same phase of the business cycle to avoid distortions in case there are more years of prosperity than that of depressions getting included in the data samples.

Average in Computing Seasonal

In all the 4 methods the individual monthly averages were averaged in order to eliminate random influences. If you noticed we used a combination of arithmetic mean and the median in our descriptions. Since arithmetic mean is affected by every item in the series, it is used only when the number of years is large.

When the period is shorter, it is better to use the median instead of arithmetic mean since usage of mean would imply that the cyclical factors or the random factors would distort the value. Median is a positional average and is not influenced by the inclusion or exclusion of a year or two.

Eliminating Seasonal Influences

The seasonal influences can be removed from time series data by dividing the actual values for each month by the seasonal index.

Trend into Seasonal into Cyclical into Irregular divided by Seasonal = Trend into Cyclical into Irregular

## Uses of Seasonal Index

Seasonal index can be used either analytically or synthetically.

I. Analytically a Seasonal Index is used to adjust original data in order to yield de-seasonalized data that permits study of short run fluctuations of a series not associated with seasonal variations. Divide each of the original observations by appropriate seasonal index for that month which is,  $T \text{ into } C \text{ into } I = T \text{ into } S \text{ into } C \text{ into } I \text{ divided by } S$

II. Synthetically seasonal index is useful in planning sales or production for specific periods. For example, If a firm expects to sell Rs. 36 Lakhs worth of goods during the coming year, average monthly sales of Rs. 3 Lakhs is expected. If the volume of sales is subjected to seasonal variations, the actual monthly values will deviate from the average. For example let's assume that the seasonal index for September is 120, the firm can expect sales of Rs. 3.6 lakhs during September and if the seasonal index for July is 90, it can expect Rs. 2.7 lakhs of sales in July.

III. Forecast for future periods are made by combining the known entity of Trend and seasonal elements. First compute the Trend ordinate for a month. Multiply this ordinate by the seasonal index for that month. This helps in eliminating cyclical and random influences.

IV. Diversification is a viable solution for avoiding seasonal influences there by helping in reducing the cost and impacts of seasonal variations.

## Limitations of Seasonal Index:

- i. No technique can precisely measure seasonal variations since all techniques are based on unrealistic assumptions and expectations that the seasonal variations are changing in a regular and systematic pattern, which in reality is not true.
- ii. The measures obtained for each month are only rough estimates.
- iii. Though the computed index of seasonal variations indicates a pattern, it may have no significance for a particular year as the seasonal index represents an average pattern of many years. If the pattern of seasonal variations in a series is not stable, any average pattern may be a bad representation of the actual seasonal variations in the given years.

Here's a summary of our learning in this session, where we have understood the measurement of seasonal variation by the methods of:

- Simple average
- Ratio to trend method
- Ratio to moving average method
- Link relative method
- Selecting the right period
- Selecting the period for computing seasonal indices
- Average in computing seasonal indices
- Eliminating seasonal influences
- Uses & Limitation of seasonal index