

STATISTICS

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CONSUMER PRICE INDEX NUMBER

'Consumer Price Index Number' is also known as 'Cost of Living Index Number' or 'Retail Price Index Number'.

Consumer Price Index Numbers are generally used to represent the average change over time in the prices paid by the ultimate consumer for a specified basket of goods and services.

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STEPS FOR CONSTRUCTION OF CONSUMER PRICE INDEX

- Determination of class of people for whom the index number is to be constructed.
- Selection of base period.
- Conducting a family budget enquiry.
- Obtaining price quotations.
- Selecting Proper weights.
- Selection of suitable methods for constructing index.



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1 Aggregate Expenditure Method : $\frac{\sum P_1 q_0}{\sum P_0 q_0} \times 100$

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Expenses	Food	Rent	Clothing	Fuel	Misc.
≈ Proportion	35%	15%	20%	10%	20%
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SOLUTION

Expenses	Weight	P_0	P_1	$I = \frac{P_1}{P_0} \times 100$	IV
Food	35	150	145	96.67	3383.45
Rent	15	30	30	100	1500.00
Clothing	20	75	65	86.67	1733.40
Fuel	10	25	23	92	920.00
Misc.	20	40	45	112.50	2250.00
Σ	100				9786.85

Cost of Living Index Number : $\frac{\sum IV}{\sum V} = \frac{9786.85}{100} = 97.87 (-2.13\%)$



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UTILITY OF CONSUMER PRICE INDEX NUMBER

- Important use is for wage negotiations and and wage contracts.
- For Govts, they are used for wage policy, Price control, Rent control, Taxation, etc.
- Used for measuring purchasing power of money.
- Used for analysing markets for particular kind of goods and services.
- They are used for estimating the real wages of the workers from the wages paid to them.



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PURCHASING POWER OF MONEY

Purchase of power of money is also called 'Value of Rupee'. As the prize of commodities increases the value of Rupee decreases.

Value of Rupee for a period is the reciprocal of Price Index of that period multiplied by 100.

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TIME SERIES

Time series is the arrangement of data according to their occurrence.

It helps to find out the variations to the value of data due to changes in time.

IMPORTANCE

- It helps for understanding past behaviour.
- It facilitates forecasting and planning.
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COMPONENTS OF TIME SERIES

Statistical Series are usually affected by multiplicity of causes like tastes and habits of people, changes in population, changes in the cost of production, changes in the income of people, etc.

The effects of these factors on time series are called components of time series. They are:

- 1 Secular Trend
- 2 Seasonal Variation
- 3 Cyclic Variation.
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Secular Trend may be defined as the changes over a long period of time. The significance is greater when the period of time is larger.

It is the general tendency of a statistical data

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1. GRAPHICAL METHOD (FREE HAND METHOD)

- This is the simplest method for measuring Trend.
- Under the method original data are plotted on the graph.
- The plotted points should be joined to get a curve.
- A straight line should be drawn through the middle area of the curve.
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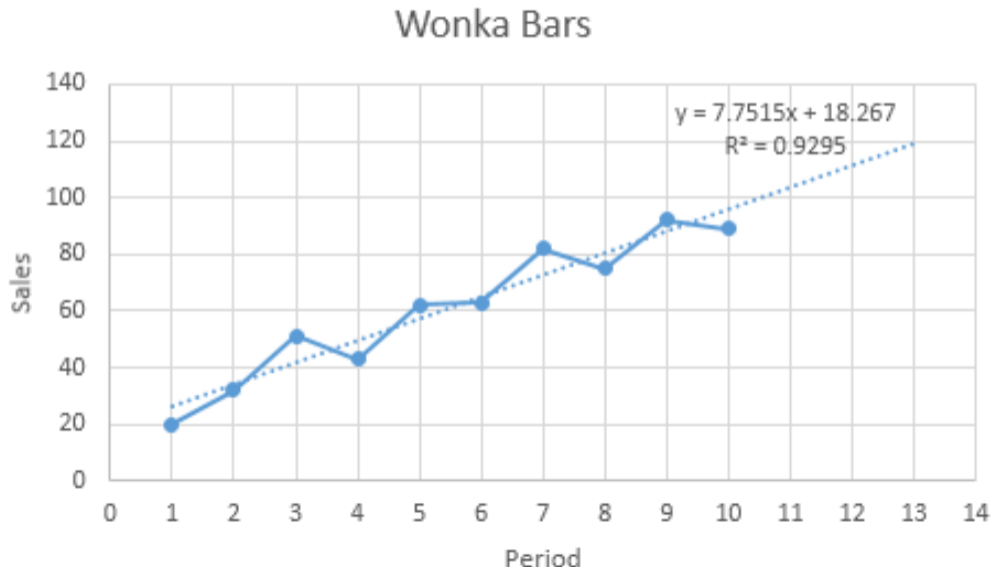
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SEMI AVERAGE METHOD

- The whole data are divided into two parts in the chronological order.
- If the number of years are odd, the middle year is omitted.
- Then average of these two groups are calculated.
- The two averages are then plotted in the graph against the middle year of each group.
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- This line is called **ward line**.
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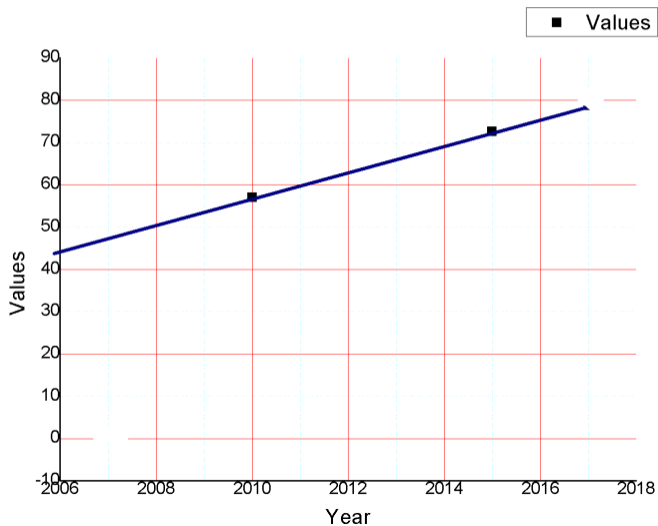
Determine trend by applying method of semi average.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Value	45	58	62	50	70	72	68	70	78	75



Year	Values	Semi Average
2008	45	
2009	58	
2010	62	$\frac{285}{5} = 57$
2011	50	
2012	70	
2013	72	
2014	68	
2015	70	$\frac{363}{5} = 72.6$
2016	78	
2017	75	





Then trend values are read from curve

Year	Values
2008	50.5
2009	53.2
2010	57
2011	60
2012	63
2013	65.8
2014	70
2015	72.6
2016	75
2017	78.5



3. METHOD OF MOVING AVERAGE

- Moving average method is an improvement over free hand curve and semi average method.
- is quite simple and is used for smoothing the fluctuations in curves.
- The trend values obtained by this method are more accurate.
- Under this method, a series of successive average should be calculated from a series of values.
- Moving average is calculated for 3, 4, 5, 6, or 7 year periods.
- The period of moving average is so chosen that it is neither be too long or too short so that trend values are not distorted or irregular fluctuations are not significant.



The moving average can be calculated as follows:

3 YEAR MOVING AVERAGE

3 year period moving average is calculated as $\frac{a + b + c}{3}$,
 $\frac{b + c + d}{3}$, $\frac{c + d + e}{3}$, $\frac{d + e + f}{3}$, ... and so on

5 YEAR MOVING AVERAGE

5 Year moving average is calculated as $\frac{a + b + c + d + e}{5}$,
 $\frac{b + c + d + e + f}{5}$, $\frac{c + d + e + f + g}{5}$, and so on.



EXAMPLE

Compute a 3 year moving average for the following data:

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sales	55	47	59	151	79	36	45	72	83	89	102



Year	sales	3 yearly moving total	3 yearly moving average
2002	55	—	—
2003	47	161	53.67
2004	59	257	85.67
2005	151	289	96.33
2006	79	266	88.67
2007	36	160	53.33
2008	45	153	51
2009	72	200	66.67
2010	83	244	81.33
2011	89	274	91.33
2012	102	—	—



4. METHOD OF LEAST SQUARES

- This is the popular method of drawing trend line.
- The trend line obtained by this method is called line of best fit.
- The trend line is represented as ' $y = a+bx$ '
- The value of 'a' and 'b' are determined by solving the following two normal equations.
- To find 'a' and 'b', we apply the method of least squares.
- Let 'E' be the sum of the squares of the deviations of all original values from their respective values derived from the equations, so that ' $E = [y-(a+bx)]^2$ '.



- As per calculus method, for minimum $\frac{\partial E}{\partial a} = 0$ and $\frac{\partial E}{\partial b} = 0$.
- On solving we get two equations: $\sum y = Na + b \sum x$ and $\sum xy = a \sum x + b \sum x^2$
- Where 'x' and 'y' represents the time and the value of the variable, 'a' and 'b' are constants and 'N' represents the total number.
- Solving these equations we get 'a' and 'b'.
- Substituting these values in the equation $y = a + bx$ will give us the trend line.



When middle year is taken as the origin, then $\sum x = 0$, then normal equation would be

$$\sum y = Na + b \sum x ; \sum y = Na ; \therefore a = \frac{\sum y}{N}$$

$$\sum xy = a \sum x + b \sum x^2 ; \sum xy = b \sum x^2 \therefore b = \frac{\sum xy}{\sum x^2}$$

Then graph may be drawn to represent trend line.



EXAMPLE

Calculate the trend values through the method of least squares and also forecast the production in 2013 and 2015.

Year	2006	2007	2008	2009	2010	2011	2012
Production	47	64	77	88	97	109	113



SOLUTION

Year 't'	Production 'y'	$x=(t-2009)$	xy	x^2
2006	47	-3	-141	9
2007	64	-2	-128	4
2008	77	-1	-77	1
2009	88	0	0	0
2010	97	1	97	1
2011	109	2	218	4
2012	113	3	339	9
Σ	595		308	28



CALCULATION OF 'A'

$$a = \frac{\sum y}{N} = \frac{595}{7} = 85$$

CALCULATION OF 'B'

$$b = \frac{\sum xy}{\sum x^2} = \frac{308}{28} = 11.$$

The equation for straight line will be 'y = a + bx'

a = 85 ; b = 11 ; ∴ y = 85 + 11x.

Then for each year trend values ('y') can be calculated by putting the value of x for that year in the above equation for straight line.



Year	'x'	'y = a + bx'	Trend value, 'y'
2006	-3	$y = 85 + 11(-3)$	52
2007	-2	$y = 85 + 11(-2)$	63
2008	-1	$y = 85 + 11(-1)$	74
2009	0	$y = 85 + 11(0)$	85
2010	1	$y = 85 + 11(1)$	96
2011	2	$y = 85 + 11(2)$	107
2012	3	$y = 85 + 11(3)$	118
2013(Expected)	4	$y = 85 + 11(4)$	129
2015(Expected)	6	$y = 85 + 11(6)$	151

Graph may drawn with above actual values and trend values for verification.



SEASONAL VARIATIONS

- Seasonal variations are quite regular and uniform and can be predicted with some amount of accuracy.
- Our past experience is the best guide for such forecasts.

EXAMPLE

Prices of rice will come down during harvesting season and there it will go up in the sowing season.



- One is interested in seasonal fluctuations in order to take the advantage of it.
- We try to purchase rice and stock it.
- At the peak of the season, the price is low and quality may be high.
- It helps in definite forecasting and adjustment of supply to possible demand of the people.



FACTORS AFFECTING SEASONAL VARIATION

- Seasonal variation occurs because of natural factors and man made conventions most of the business and economic activities vary in systematic pattern during the season of the year.
- The major factors responsible for seasonal variations are
 - Climate and weather conditions.
 - Customs, traditions and habits.
- The most important factor causing seasonal variation is the changes in the climate and weather conditions such as rainfall, temperature, etc.



- They act on different products differently. e.g. Sales of umbrella will be more in rainy season and also greater demand for cold drinks during summer.
- The nature is primarily responsible for seasonal variations.
- Custom tradition and habits have their in back
- For example on certain occasions like Deepavali, Christmas etc., there is big demand for sweets and gifts, during Onam, there will be higher sales of textile goods there is huge demand for gold during marriage season.



MEASUREMENT OF SEASONAL VARIATION

Methods for measuring Seasonal Variation.

- 1 Method of averages.
- 2 Ratio to trend method.
- 3 Ratio to moving average method.
- 4 Method of link relatives.



SAMPLE PROBLEM

Fit a straight line trend by the method of least squares and estimate the value of 2021

Year	2012	2013	2014	2015	2016	2017	2018	2019
Values	380	400	650	720	690	600	870	930

