

4.3. Uses Least square method to Estimate Trend.

The technique of

Least Square method.

The technique of least square regression was applied and demonstrated for bivariate in chapter 2. In order to use this method to obtain a trend line for a time series, it is necessary to consider the series of data as bivariate.

The procedure is given below.

- (i) Take the physical time points as values. (Example: 1, 2, 3... or ... -2, -1, 0, 1, 2...)
- (ii) Take the time series values as dependent variable.
- (iii) Calculate least square regression line Y , on X by using following formulae.

Slope and Y -intercept of trend line ($Y = bx + a$) can be evaluate by using following formulae.

* $b = \text{Slope.}$

$$b = \frac{n \sum XY - (\sum X)(\sum Y)}{n \sum X^2 - (\sum X)^2}$$

* Y -Intercept = a

$$a = \bar{Y} - b\bar{X}$$

$$a = \frac{\sum Y}{n} - \frac{b \sum X}{n}$$

Worked Example (01)

The annual income of 8 Years of a particular company is as follows. Construct the least square trend line equation and plot the trend line on the time series graph.

Year	2010	2011	2012	2013	2014	2015	2016	2017
Annual Income (₹.m)	02	03	04	04	05	07	08	10

Solution

Prepare a table as follows.

Year	X	Y (Income)	XY	X ²
2010	01	02	02	01
2011	02	03	06	04
2012	03	04	12	09
2013	04	04	16	16
2014	05	05	25	25
2015	06	07	42	36
2016	07	08	56	49
2017	08	10	80	64
	$\Sigma X =$	$\Sigma Y =$	$\Sigma XY =$	$\Sigma X^2 =$
	36	43	239	204

(i) Equation of a Trend Line.

b = Slope

$$b = \frac{n \Sigma XY - (\Sigma X)(\Sigma Y)}{n \Sigma X^2 + (\Sigma X)^2}$$

$$b = \frac{8 \times 239 - (36)(43)}{8 \times 204 - (36)^2}$$

$$b = \frac{1912 - 1548}{1632 - 1296}$$

$$b = \frac{364}{336}$$

$$b = 1.08$$

Y-Intercept = a

$$a = \frac{\sum Y - b \sum X}{n}$$

$$a = \frac{43 - 1.08 \times 36}{8}$$

$$a = 5.375 - 4.86$$

$$a = 0.515$$

Equation of a trend line $Y = bx + a$

$$Y = 1.08X + 0.515$$

(i) Graph

$$Y = 1.08X + 0.515$$

When $X = 2$ (2011)

$$Y = 1.8(2) + 0.515$$

$$Y = 3.6 + 0.515$$

$$Y = 4.115$$

$$A \equiv (2, 4.12)$$

$$A \equiv (2011, 4.12)$$

$$Y = 1.08X + 0.515$$

When $X = 6$ (2015)

$$Y = 1.08(6) + 0.515$$

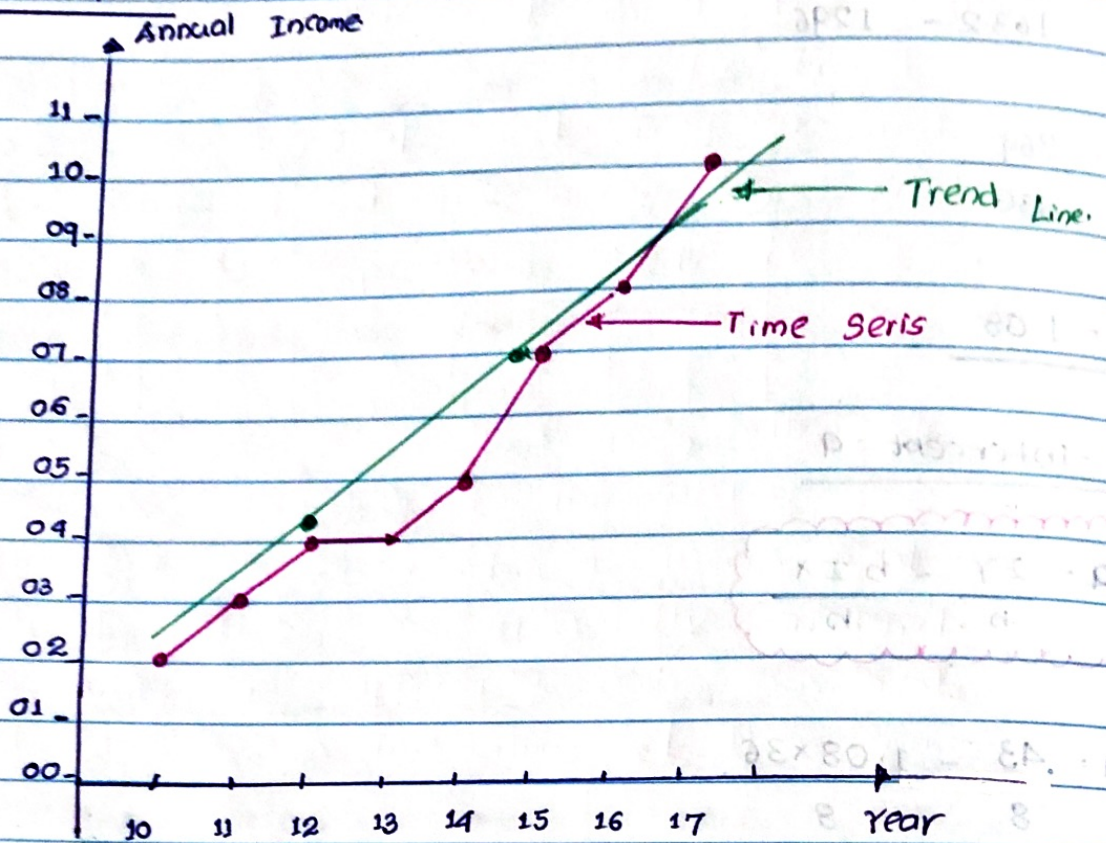
$$Y = 6.48 + 0.515$$

$$Y = 6.995$$

$$B \equiv (6, 7.000)$$

$$B \equiv (2015, 7.000)$$

Cr) Graph.



Exercise

Calculate the time series trend using least square method for following time series.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Production Units '000	45	48	55	63	65	72	84	90	87	82