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Application of Time Series

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Abstract—*this is an important study of statistical methodology for the analysis of Time series which is more appropriate for a special class of longitudinal designs of research. These designs of the study typically involve subjects (seasonal variation, Cyclical Variations) and other research units that are measured repeatedly at regular intervals over a large number of observations. Time series analysis can be measured as an exemplar of a longitudinal design. A time series analysis can help us to understand the underlying process of nature, the pattern of change over the domain of the function or evaluate the effects (range) of either a planned or unplanned intervention. The data's particularly in the field of social sciences are dynamic in nature (Agricultural and Industrial production increases every year or due to improved medical facilities) there is decline in the death rate over a period of time. It gives the information about increment or decrement in sales or exports of various products over a period of years. This distinct change (either increasing or decreasing) can be observed in the values of time-series.*

Keywords—*Average, Trend Value, Time Series, Seasonal Variations, Cyclical Variations.*

I. INTRODUCTION

A time series is a sequence of values of a phenomenon arranged in order of their occurrence. Mathematically it can expressed as a function, namely $y_n = f(t_n)$, where domain t represents time and range y represents the corresponding values. That is, the values y_1, y_2, y_3 ….. of a phenomenon with respect to time periods t_1, t_2, t_3 ….. Form a Time Series. Various methods can be applied to study the time-series which leads to analysis of time series. By studying the past behavior of the characteristics, the nature of variations in the values can be determined. The values in the past can be compared with the present values of comparisons at different places during same time period can also be made. The study of time series helps in formulation of future plans and policies. It also enables us to forecast the future changes. A businessman, for example, is interested in knowing likely sales, say, on month to month basis, so as to adjust the production schedule. The study of population, over a given time span, is the most important tool for a country's planning authorities in many ways, so as to allocate financial resources according to various portfolios such as agriculture, industry, education, etc. or amongst different geographical regions and states. Using the past data, financial institutions like banks can plan the future growth of deposits and advances; so that new and more attractive schemes can be introduced.

II.EXAMPLE-1

Calculate 3 yearly moving averages from the following time series. Also plot the given data and the moving averages on a graph paper.

Year	2001	2002	2003	2004	2005	2006	2007
Sales	46	53	72	58	62	78	61

Table No.:1

Year	Sales	3 yearly moving total	3 yearly moving averages

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2001	**46**	**--------**	**--------**
2002	**53**	**46 + 53 + 72 = 171**	**171 / 3 = 57**
2003	**72**	**53 + 72 + 58 = 183**	**183 / 3 = 61**
2004	**58**	**72 + 58 + 62 = 192**	**192 / 3 = 64**
2005	**62**	**28 + 62 + 78 = 198**	**198 / 3 = 66**
2006	**78**	**62 + 78 + 61 = 201**	**201 / 3 = 67**
2007	**61**	**--------**	**--------**

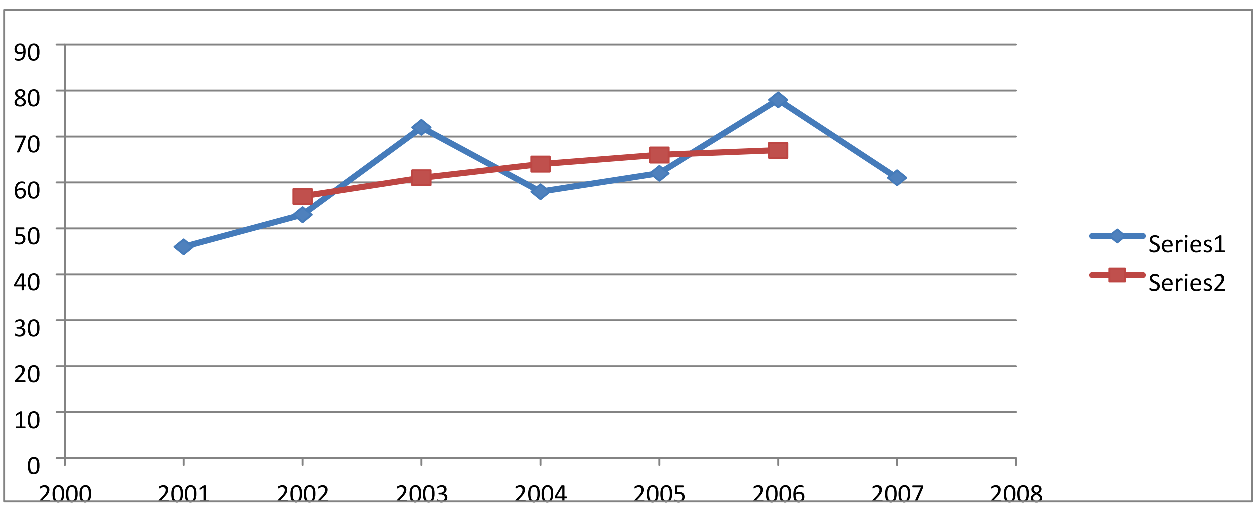

Figure:1

III. EXAMPLE 2.

Calculate 4 yearly moving averages from the following time series. Also plot the given data and the moving averages on a graph paper.

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Trend value	**60**	**69**	**81**	**86**	**78**	**93**	**102**	**107**	**100**	**99**

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Table No.:2

Year	Trend value	4 yearly moving total	Centered Total	4 yearly moving averages
1998	60	--------	--------	--------
1999	69	--------	--------	--------
		60 + 69 + 81 + 86 = 296		
2000	81		296 + 314 =610	610 / 8 = 76.25
		69 + 81 + 86 + 78 = 314		
2001	86		314 + 338 =652	652 / 8 = 81.5
		81 + 86 + 78 + 93 = 338		
2002	78		338 + 359 =697	697 / 8 = 87.125
		86 + 78 + 93 + 102 = 359		
2003	93		359 + 380 =739	739 / 8 = 92.375
		78 + 93 + 102 + 107 = 380		
2004	102		380 + 402 =782	782 / 8 = 97.75
		93 + 102 + 107 + 100 = 402		
2005	107		402 + 408 =810	810 / 8 = 101.25
		102 + 107 + 100 + 99 = 408		
2006	100	--------	--------	--------
2007	99	--------	--------	--------

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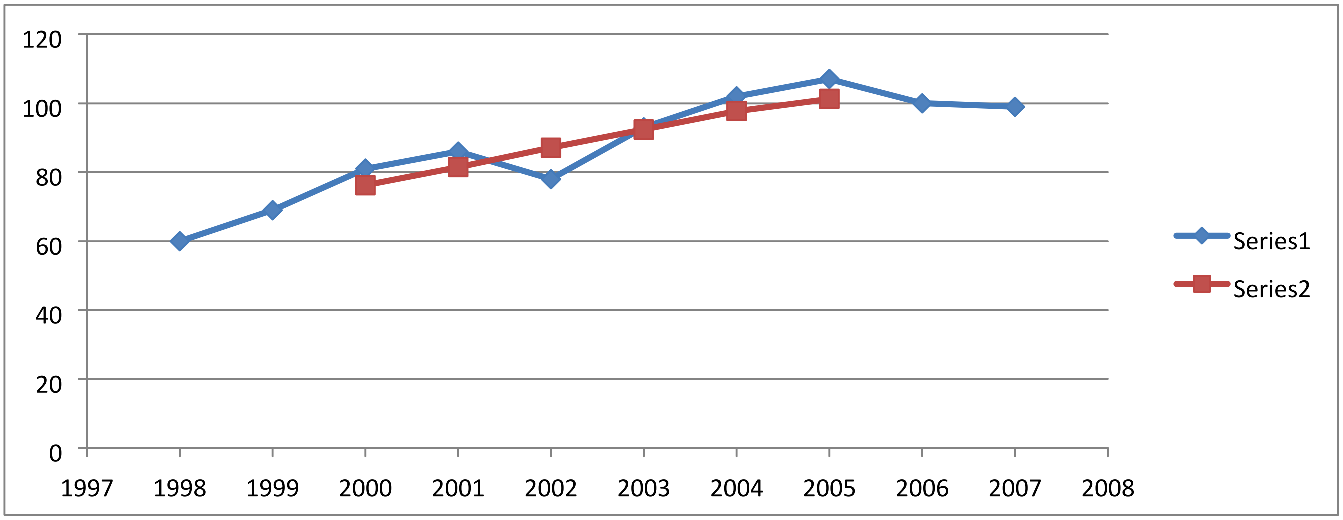

Figure No.:2

III.COMPONENTS OF TIME SERIES

The fluctuations in a time series are due to one or more of the following factors which are called "components" of time series.

(i) Secular Trend: The general tendency of the data, either to increase or to remain constant is called Secular Trend. It is smooth, long term moment of the data. The changes in the values are gradual and continuous. An increasing demand for luxury items like refrigerators or color T.V. sets reflects increasing trend. The production of steel, cement, vehicles shows a rising trend. On the other hand, decrease in the imports may be linear or curvilinear, in practice, curvilinear trend is more common. Trend in due to long term tendency. Hence it can be evaluated if the time series is available over a long duration.

(ii) Seasonal Variations: The regular seasonal changes in the time series are called "Seasonal Variations". It is observed that the demand for umbrellas, raincoats, reaches a peak during monsoon or the advertisements of cold drinks, ice creams get a boom in summer. The demand for greeting cards, sweets, increases during festivals like Diwali, Christmas. In March, there is maximum withdrawal of bank deposits for adjustments of income-tax payment, so also various tax-saving schemes shoot up during this period. The causes, for these seasonal fluctuations, are thus, the changes in weather conditions, the traditions and customs of people etc. The seasonal component is measured

to isolate these changes from the trend component and to study their effect, so that, in business, future production can be planned accordingly and necessary adjustments for seasonal changes can be made.

(iii) Cyclical Variations: These are changes in a time series, occurring over a period which is more than a year. They are recurring and periodic in nature. The period may not be uniform. These fluctuations are due to changes in a business cycle. There are four important phases of any business activity viz. prosperity, recession, depression, and recovery. During prosperity, the business flourishes and the profit reaches a maximum level. Thereafter, in recession, the profit decreases, reaching a minimum level during depression. After some time period, the business again recovers (recovery) and it is followed by period of prosperity. The variations in the time series due to these phases in a business cycle are called "Cyclical Variations".

(iv) Irregular Variations: The changes in the time series which cannot be predicted and are eractic in nature are called "Irregular Variations". Usually, these are short term changes having significant effect on the time series during that time interval. These are caused by unforeseen events like wars, floods, strikes, political changes, etc. During IranIraq War or recent Russian revolution, prices of petrol and petroleum products soared very high. In recent budget, control on capital issues was suddenly removed. As an effect, the all India-Index of share market shooted very high, creating all time record. If the effect of other components of the time series is eliminated, the remaining variations are called "Irregular or Random Variations". No forecast of these changes can be made as they do not reflect any fixed pattern.

The purpose of studying time series is to estimate or forecast the values of the variables. As there are four components of the time series, these are to be studied separately. There are two types of models which are used to express the relationship of the components of the time series. They are addictive model and multiplicative model.

Let O = Original Time Series
T = Secular Trend
S = Seasonal Variations
C = Cyclical Variations and I
= Irregular Variations

In Addictive model, it is assumed that the effects of the individual components can be added to get the resultant value of the time series, that is, the components are independent of one another. The model can be expressed

$$O = T + S + C + I$$

In Multiplicative model, it is assumed that the multiplication of the individual effects of the components results in the time series, that is, the components are due to different causes but they are not necessarily independent, so that, changes in any one of them can affect the other components. This model is more commonly used. It is expressed as

$$O = T \times S \times C \times I$$

If we want to estimate the values in the time series, we have to first estimate the four components and then combine them to estimate the value of the time series. The irregular variations cannot be predicted and hence estimates of the first three components only can be found. However, we will restrict ourselves, to discuss methods of estimating the first component, namely Secular Trend.

IV. LEAST SQUARE METHOD

When the values in the time series are plotted, a rough idea about the type of trend whether linear or curvilinear can be obtained.

Then, accordingly a linear or second degree equation can be fitted to the values. In this chapter, we will discuss linear trend only.

Let $y = a + bx$ be the equation of the straight line trend where a, b are constants to be determined by solving the following normal equations,

$$\sum y = na + b\sum x$$
$$\sum xy = a\sum x + b\sum x^2$$

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Where y represents the given time series.

We define x from years such that $\sum x = 0$. So substituting $\sum x = 0$ in the normal equations and simplifying, we get
$b = \frac{\sum xy}{\sum x_2}$ and $a = \bar{y} = \frac{\sum y}{n}$

Using the given set of values of the time series, a, b can be calculated and the straight line trend can be determined as y = a + bx. This gives the minimum sum of squares of deviations between the original data and the estimated trend values. The method provides estimates of trend values for all the years. The method has mathematical basis and so element of personal bias is not introduced in the calculations.

The trend line equation is given by y=ax+b where $a = \frac{\sum y}{n}$ & $b = \frac{\sum xy}{\sum x^2}$

Here x value is selected depending upon the data n. **Case – I** If n is odd (n = 5, 7, 9) then x values are taken as …………, _4, _3, −2, −1, 0, 1, 2, 3, 4…………

Case – II If n is even (n = 4, 6, 8) then x values are taken as …………, _7, _5, −3, −1, 1, 3, 5, 7…………..

V.EXAMPLE 3

Case – I (n is odd)

Fit a straight line trend for the following data and hence find the trend value for the year 1999.

Year	1994	1995	1996	1997	1998
Profit	**33**	**31**	**35**	**37**	**34**

Table No.:3

Year	Profit Y	x	x2	xy	Trend value y = 34 + 0.8x
1994	**33**	**_2**	**4**	**_66**	**y = 34 + 0.8(_2) = 32.4**
1995	**31**	**_1**	**1**	**_31**	**y = 34 + 0.8(_1) = 33.2**
1996	**35**	**0**	**0**	**0**	**y = 34 + 0.8(0) = 34**
	37	**1**	**1**	**37**	**y = 34 + 0.8(1) = 34.8**

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1997					
1998	**34**	**2**	**4**	**68**	**y = 34 + 0.8(2) = 35.6**
Total	**∑y=170**	**∑x=0**	**∑x ²=10**	**∑xy=8**	**-----**

$$a = \frac{\sum y}{n} = \frac{170}{5} = 34 \ \& \ b = \frac{\sum xy}{\sum x^2} = \frac{8}{10} = 0.8$$

Trend line equation is y = a + bx → For the year 1999 → x = 3 y_{1999} = 34 + 0.8(3) = 36.4

y = 34 + 0.8x

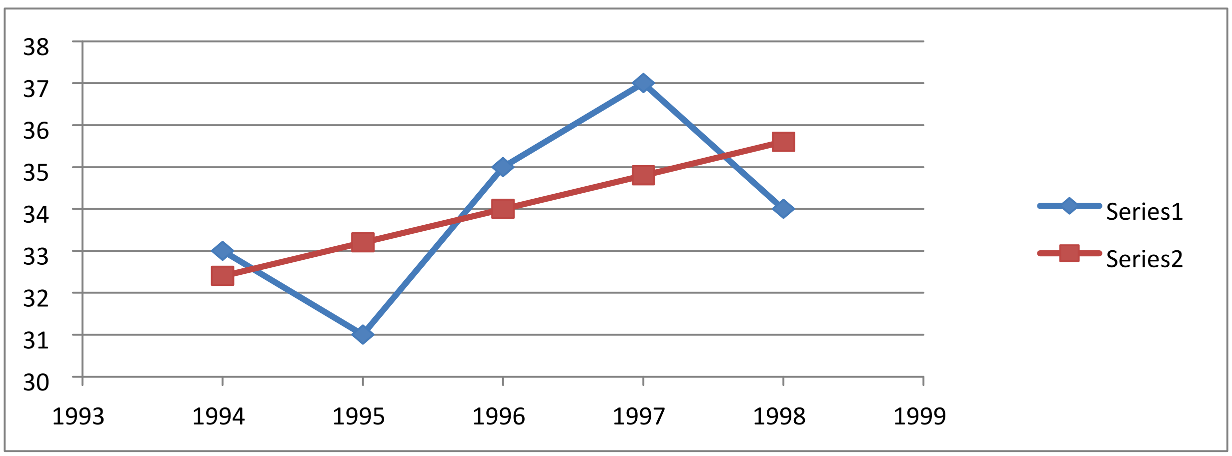

Figure No.:3

VI.EXAMPLE 4.

<u>**Case – II**</u> (n is even)

Year	**2006**	**2007**	**2008**	**2009**
Profit in k's	**41**	**43**	**46**	**48**

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Fit a straight line trend for the following data & hence find profit for the year 2010.
Table No.;4

Year	Profit y	X	x2	xy	Trend value y = 34 + 0.8x
2006	41	_3	9	_126	y = 44.5 + 1.2 (_3) = 40.9
2007	43	_1	1	_43	y = 44.5 + 1.2 (_1) = 43.3
2008	46	1	1	46	y = 44.5 + 1.2 (1) = 45.7
2009	48	3	9	144	y = 44.5 + 1.2 (3) = 48.1
Total	$\sum y=178$	$\sum x=0$	$\sum x^2=20$	$\sum xy=24$	-----

$a = \frac{\sum y}{n} = \frac{178}{4} = 44.5$ & $b = \frac{\sum xy}{\sum x^2} = \frac{24}{20} = 1.2$

$y = 44.5 + 1.2x$

Trend line equation is y = a + bx →
For the year 2010→ x = 5

$y_{2010} = 44.5 + 1.2\,(3) = 50.5$

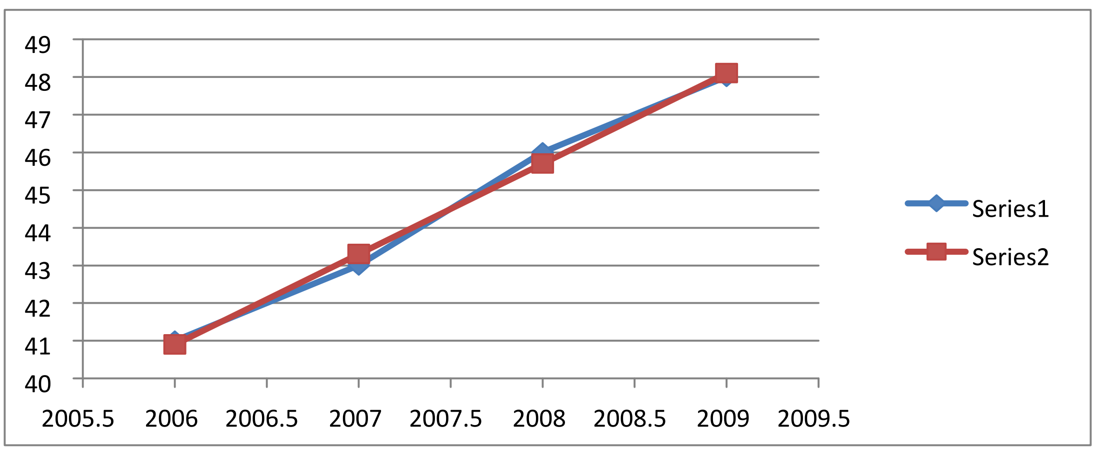

Figure No.:4

V.CONCLUSION

Thus we have studied that Time series analysis is a tremendous potential method for the study of behavioral sciences and longitudinal data, analysis have the potential to address research questions that could not be addressed, or only addressed indirectly, by cross-sectional methods. Time series analysis is one of the large numbers of computational procedures that have been developed specifically for the analysis of longitudinal data during the last thirty years.

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REFERENCES

[1] Welling, Saraph and Diwanji, Mathematical & Statistical Techniques – II, Manan Prakashan.
[2] S.P. Gupta, Statistical Methods, Sultan Chand & Sons.
[3] V.K. Kapoor, Fundamental of Mathematical Statistics, S. Chand & Sons.
[4] Paul S.P.Cowpertwait & Andrew V.Metcalfe, Springer.
[5] Robert H. Shumway & Dadiv S. Stoffer, Springer.
[6] Jonathan D. Cryer & Kung-Sik Chan.
[7] Ruey S.Tsay Willey.
[8] Galit Shmueli & Kenneth C. Lichtendahl Jr.
[9] Box GEP, Jenkins GM (1976). Time Series Analysis, Forecasting and Control, Holden-Day: San Francisco.
[10] Wang S, Feng J, Liu G (2013). Application of Seasonal Time Series Model in the precipitation forecast. Mathematical and Computer Modelling, 58(3&4): 677 – 683.
[11] Wei Wws (1990). Time Series Analysis. Addison-Wesley Publishing, Reading, MA, USA.
[12] Yusuf F, Kane IL (2012). Modeling Monthly Rainfall Time Series using ETS state space and Sarima models. International Journal of Current Research, 4(9): 195 – 200.
[13] Etuk EH, Moffat IU, Chims BE (2013). Modelling Monthly Rainfall data of Port Harcourt, by Seasonal Box-Jenkins Methods International Journal of Sciences,2:,60-65
[14] Friston, K. J., Holmes, A. P., Poline, J. B., Grasby, P. J., Williams, S. C. R., Frackowiak, R. S. J., et al. (1995). Analysis of fMRI time series revisited. Neuroimaging 2, 45–53.