TIME SERIES

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A time series is set of data collected at successive point in a time or over successive period of time .

A time series is a collection of observations made sequentially through time

The interval between observations can be any time interval (hours within days, days, weeks, months, years, etc).

Some examples of time series are:

- Malaria incidence or deaths over calendar years
- Daily maximum temperatures
- Hourly records of babies born at a maternity hospital
- monthly unemployment,
- weekly measures of money supply,
- daily closing prices of stock indices, and so on

- An analysis of a single sequence of data is called univariate time-series analysis
- An analysis of several sets of data for the same sequence of time periods is called multivariatetime-series analysis or, more simply, multiple time-series analysis

NECESSITY OF TIME ANALYSIS:

- It helps us to understand past behavior of time series data.
- With the help of time series analysis, we can compare the actual performance and analyze the cause of variation.
- Analysis of time series show that the observed values of the variable are always fluctuating from time to time. The fluctuations are due to various factors like increase in population, change in habits and tastes of population, whatever condition etc.

- Time series analysis and its application have become important in various field of research such as business, economics, (weekly share prices, monthly profit.), engineering, medicine metrology (daily rain fall, wind speed, temperature), sociology (crime figures number of arrest etc.)

COMPONENT OF TIME SERIES

Fluctuation in a time series is mainly due to four basic components.

1 Secular trend or trend (T)

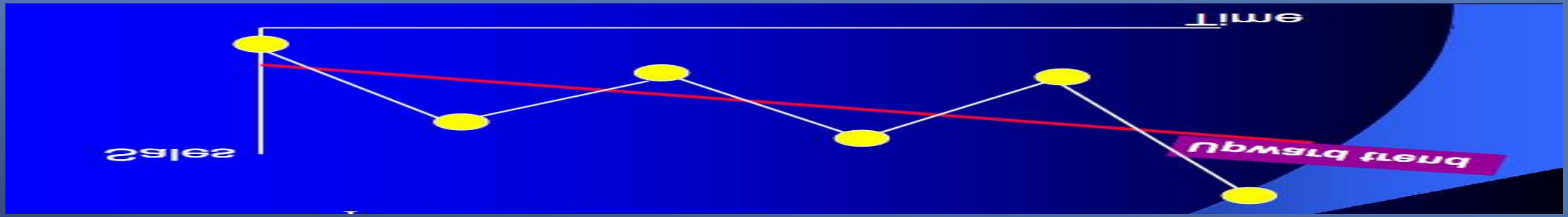
2 Seasonal variation (S)

3 Cyclical variation or cyclic fluctuation (C)

4 Irregular or random moments (I)

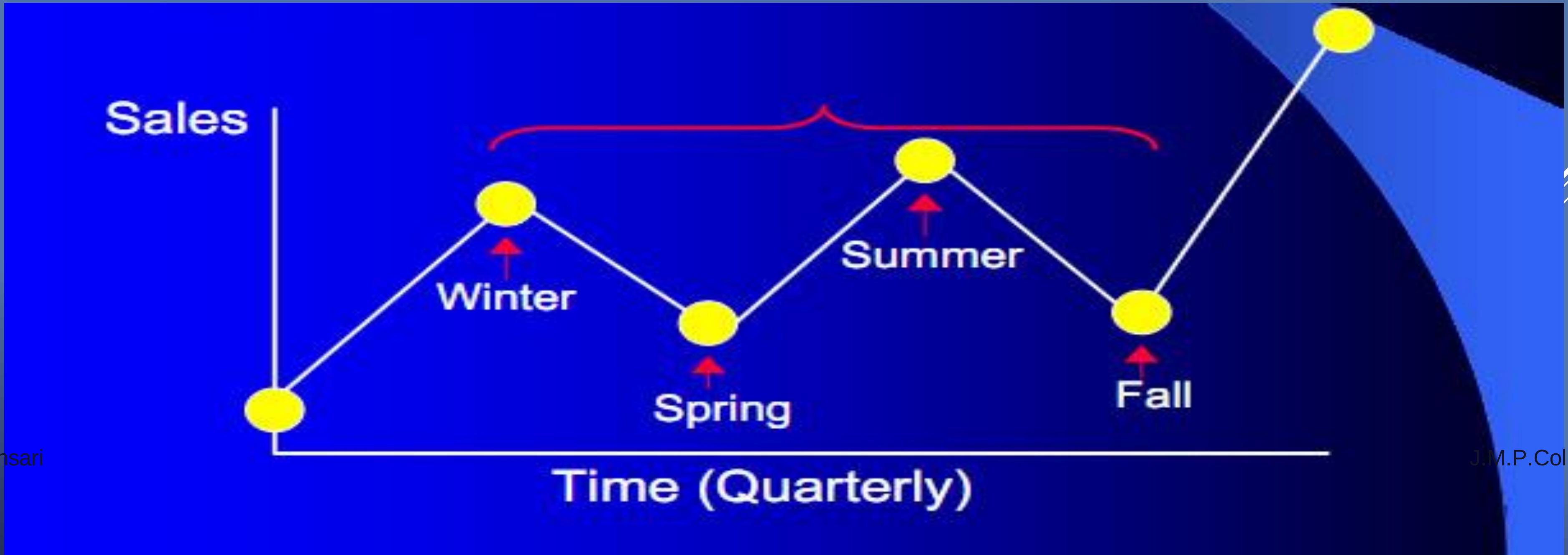
Secular trend or trend (T)

- Trend is the phenomenon of long term changed in a recorded data series, generally in the same direction throughout the span of the series.
- A sequence plot of time series (the time series value plotted vertically with respect to time itself on the horizontal axis) will usually reveal the presence of trend as a gentle upward or downward “drift” of the data path.
- Upward sloping trend paths in a real- value time series may be indicative of growth phenomenon, a downward sloping path suggest contraction.
- In a money-value time series an upward sloping path may represent some combination of real growth and inflation; a downward sloping trend path might indicate contraction with deflation.
- Trend is usually the result of long-term factors such as changes in the population, demographics, technology, or consumer preferences.



SEASONAL VARIATION

- This is the pattern of variation within time series which repeat itself year to year.
- Seasonality may be associated with agricultural functions, seasonal weather pattern, custom and convention, or religious or secular holidays.
- It is important to remember that a seasonable pattern in one time series may or may not resemble that in another time series.
- Fans and air-conditioned sales are high in the summer month, agricultural sales are high at harvest time, RAIN CAOTS, UMBERELLA SALES HIGH IN MONSOON



Any regular pattern of sequences of values above and below the trend line lasting more than one year can be attributed to the *cyclical component*.

Usually, this component is due to multiyear cyclical movements in the economy.

❑Cyclical Variations:

Cyclical variations are recurrent upward or downward movements in a time series but the period of cycle is greater than a year. Also these variations are not regular as seasonal variation.

A business cycle showing these oscillatory movements has to pass through four phases-prosperity, recession, depression and recovery. In a business, these four phases are completed by passing one to another in this order.

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- **Irregular variation:**

Irregular variations are fluctuations in time series that are short in duration, erratic in nature and follow no regularity in the occurrence pattern. These variations are also referred to as residual variations since by definition they represent what is left out in a time series after trend ,cyclical and seasonal variations. Irregular fluctuations results due to the occurrence of unforeseen events like :

- FLOODS,
- EARTHQUAKES,
- WARS,
- FAMINES

- How the components relate to the original series: a model that expresses the time series variable Y in terms of the components *T* (trend), *C* (cycle), *S* (seasonal) and *I* (irregular).
- Additive components model & multiplicative components model.

Additive model: Y = T + C + S + I

Multiplicative model: Y = T *C * S * I

- **Regression model:**

Trend can be described by a straight line or a smooth line.

Linear trend: $Y = a + bt$

Here *Y* is the predicted value for the trend at time *t*.

The symbol *t* used for the variable represents time and takes integer values 1,2,3,… The slope *b* is the average increase or decrease in *T* for each one-period increase in time.

Time trend equations can be fit to the data using the *method of least squares.*

LEAST-SQUARE PARAMETER ESTIMATES

Equating these derivatives to zero and dividing by -2, we get

$$\Sigma(Y_i - a - bX_i) = 0 \qquad (A.1)$$

$$\Sigma X_i(Y_i - a - bX_i) = 0 \qquad (A.2)$$

Finally by rewriting Eqs. (A.1) and (A.2), we obtain the pair of simultaneous equations:

$$\Sigma Y_i = aN + b\Sigma X_i \qquad (A.3)$$

$$\Sigma X_i Y_i = a\Sigma X_i + b\Sigma X_i^2 \qquad (A.4)$$

Now we can solve for *a* and *b* simultaneously by multiplying (A.3) by ΣX_i and Eq. (A.4) by *N*:

$$\Sigma X_i \Sigma Y_i = aN\Sigma X_i + b(\Sigma X_i)^2 \qquad (A.5)$$

$$N\Sigma X_i Y_i = aN\Sigma X_i + bN(\Sigma X_i)^2 \qquad (A.6)$$

Subtracting Eq. (A.5) from Eq. (A.6), we get

$$N\Sigma X_i Y_i - \Sigma X_i \Sigma Y_i = b[N(\Sigma X_i)^2 - (\Sigma X_i)^2] \quad \textbf{(A.7)}$$

from which it follows that

$$b = (N\Sigma X_i Y_i - \Sigma X_i \Sigma Y_i)/(N(\Sigma X_i)^2 - (\Sigma X_i)^2) \quad \textbf{(A.8)}$$

Given b, we may calculate a from Eq. (A.9):

$$a = (\Sigma Y_i - b\,\Sigma X_i)/N \qquad \textbf{(A.10)}$$

Moving average method

1. **Odd moving average method**:

a) 3 yearly moving average method

b) 5 yearly moving average method

2. Even moving average method

4 yearly moving average

Suppose we average the first 5 values (for 1992 to 1996).

$$\frac{690 + 674 + 665 + 648 + 650}{5}$$

Decide with which year you would plot this value against.

Ans: Since it is an average, we plot at 1994, the middle of the 5 years.

Year	Births ('000s)
1992	690
1993	674
1994	665
1995	648
1996	650
1997	643
1998	636
1999	622
2000	604
2001	595
2002	596

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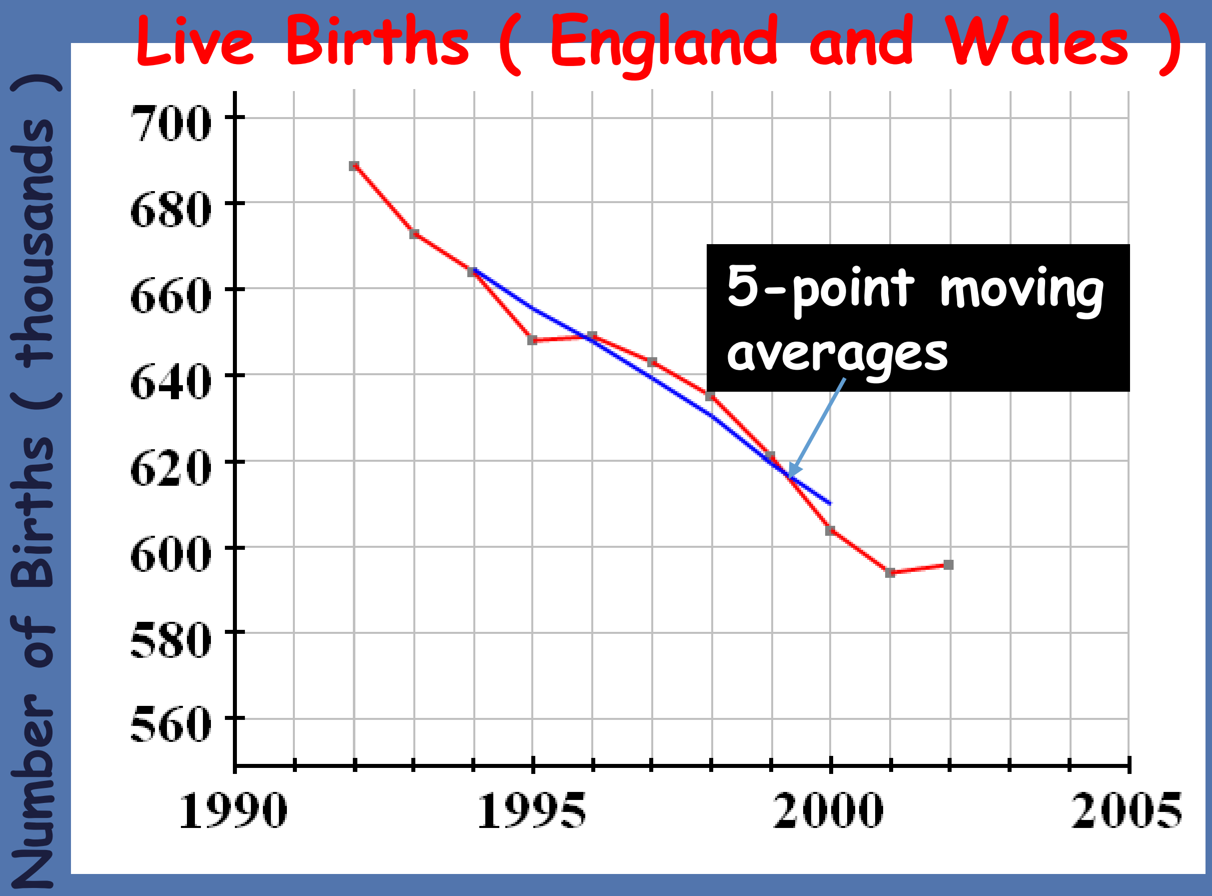
1992	~~690~~	
1993	674	
1994	665	665
1995	648	656
1996	650	648
1997	650	640
1998	636	631
1999	622	620
2000	604	611
2001	595	
2002	596	

For the 2nd average, we drop the value for the 1st year (1992) and include the value for 1997.

$$\frac{(674 + 665 + 648 + 650 + 643)}{5}$$

We continue like this moving the averages forward . . .

until we no longer have 5 values to average. We can now plot the points on the time series graph.



Live Births (England and Wales)
Number of Births (thousands)
700
680
660
640
620
600
580
560
1990
1995
2000
2005
5-point moving averages

To predict the birth rate for 2003, we extend the trend line to find the next moving average.

An average of 600 means that the total for the 5 years from 1999 to 2003 is 5 × 600 = 3000

To find the 2003 estimate we can subtract the values for the 4 years we know (1999 to 2002).

Estimate for 2003

= 3000 -

= 583

year	sales in thousand	4 yearly moving total	4 yearly centered total	4 yearly centered average
1992	520			
1993	510			
		2085		
1994	525		4162	520
		2077		
1995	530		4154	519
		2077		
1996	512		2507	313
		2112		
1997	510		2548	318
		2130		
1998	550		2539	317
		2152		
1999	540		2530	316
		2117		
2000	530		2533	316
		2087		
2001	532			
2002	515			
2003	510			