Statistics 2
Chapter 13

Time Series and Forecasting

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Chapter 13

Time Series and Forecasting

GOALS

When you have completed this chapter, you will be able to:

ONE

Define the four components of a time series.

TWO

Determine a linear trend equation.

THREE

Compute a moving average.

FOUR

Compute the trend equation for a nonlinear trend.

Chapter 13 *continued*

Time Series and Forecasting

GOALS
When you have completed this chapter, you will be able to:

FIVE
Use trend equations to forecast future time periods and to develop seasonally adjusted forecasts.

SIX
Determine and interpret a set of seasonal indexes.

SEVEN
Deseasonalize data using a seasonal index.

Components of a Time Series

- A Time Series is a collection of data recorded over a period of time - usually weekly, monthly, or quarterly. There are four components to a time series:
  - › The Secular Trend is the long run direction of the time series.
  - › The Cyclical Variation is the fluctuation above and below the long-term trend line.

Components of a Time Series

› The Seasonal Variation is the pattern in a time series within a year. These patterns tend to repeat themselves from year to year.

› The Irregular Variation is divided into two components: Episodic variations are unpredictable, but can usually be identified, such as a flood. Residual variations are random in nature.

Linear Trend

The long term trend equation (linear) estimated by the least squares equation for time t is:

$$Y' = a + bt$$

$$b = \frac{\Sigma tY - (\Sigma Y)(\Sigma t)\,/\,n}{\Sigma t^2 - (\Sigma t)^2\,/\,n}$$

$$a = \frac{\Sigma Y}{n} - b\left(\frac{\Sigma t}{n}\right)$$

EXAMPLE 1

- The owner of Strong Homes would like a forecast for the next couple of years of new homes that will be constructed in the Pittsburgh area. Listed below are the sales of new homes constructed in the area for the last 5 years.

Year	Sales ($1000)
1994	4.3
1995	5.6
1996	7.8
1997	9.2
1998	9.7

EXAMPLE 1 *continued*

- Develop a trend equation using the least squares method by letting 1994 be the time period 1. What is the estimated home sales for 2000?
  - › a=3.00, b=1.44
  - › Thus Y'=3.00+1.44(7) = 13.08

The Moving-Average Method

- The moving-average method is used to smooth out a time series. This is accomplished by "moving" the arithmetic mean through the time series.

- The moving-average is the basic method used in measuring the seasonal fluctuation.

- To apply the moving-average method to a time series, the data should follow a fairly linear trend and have a definite rhythmic pattern of fluctuations.

Nonlinear Trends

- If the trend is not linear but rather the increases tend to be a constant percent, the Y values are converted to logarithms, and a least squares equation is determined using the logs.

$$\log(Y') = [\log(a)] + [\log(b)]t$$

Seasonal Variation

- The method most commonly used to compute the typical seasonal pattern is called the ratio-to-moving-average method.
  - › It eliminates the trend, cyclical, and irregular components from the original data (Y).
  - › The numbers that result are called the typical seasonal indexes.

Determining a Seasonal Index

- Step 1: Determine the moving total for the time series.

- Step 2: Determine the moving average for the time series.

- Step 3: The moving averages are then centered.

- Step 4: The specific seasonal for each period is then computed by dividing the Y values with the centered moving averages.

- Step 5: Organize the specific seasonals in a table.

- Step 6: Apply the correction factor.

Deseasonalizing Data

- A set of typical indexes is very useful in adjusting a series (sales, for example)

- The resulting series (sales) is called *deseasonalized* sales or *seasonally adjusted* sales.

- The reason for deseasonalizing a series (sales) is to remove the seasonal fluctuations so that the trend and cycle can be studied.