Forecasting Module 1
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Learning Objectives
- Identify the time series components in a graph
- Make a time series graph using Minitab

What is a time series?
- Time series data is collected in equally spaced, consecutive time periods.
- Examples:
  - Quarterly data
  - Monthly data
  - Annual data
  - Daily data
Entering data in Minitab

- Time series data is entered in a single column with the data in time sequence order.
- When forecasting, usually there will be only one variable of interest such as revenue, sales, etc; hence, the single column in Minitab.

Example:

- Time Series Data for Greeting Card Sales

<table>
<thead>
<tr>
<th>Year</th>
<th>Qtr1</th>
<th>Qtr2</th>
<th>Qtr3</th>
<th>Qtr4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>222</td>
<td>339</td>
<td>336</td>
<td>878</td>
</tr>
<tr>
<td>1999</td>
<td>443</td>
<td>413</td>
<td>398</td>
<td>1143</td>
</tr>
<tr>
<td>2000</td>
<td>695</td>
<td>698</td>
<td>737</td>
<td>1647</td>
</tr>
</tbody>
</table>

Data is collected in time sequence order.

Example in Minitab
Time Series Plots

- Time series components are identified by examining a graph of the data.
- A graph of time series data is called a time series plot in Minitab.
- The x-axis must always have the time variable while the y-axis has the variable of interest.

Vocabulary

- To develop an adequate forecast, one must be able to identify the four time series components in the data:
  - 1) trend

Trend

- “Overall upward or downward tendency of the data”

Weiers, 2005, p. 798
Example of Upward Trend

Quiz Time

Which of the graphs below shows trend?

Quiz Time Answer

- The graph below shows upward trend.
- The graph below is described as stationary since it has no trend.
Vocabulary

To develop an adequate forecast, one must be able to identify the four time series components in the data:

1) Trend
2) Seasonality

Seasonality

“Variation in a time series due to periodic fluctuations that repeat over a period of one year or less”

Winters, 2005, p. 798

Example of Seasonality
Quiz Time

Which of the graphs below show seasonality?

Monthly Sales at Gap, Inc. (in millions of dollars)

Touring Quarterly Sales of Harley Davidson (in thousands of dollars)

Quiz Time Answer

This graph shows seasonality - note the high every year.

This graph shows trend but no seasonality.

Vocabulary

To develop an adequate forecast, one must be able to identify the four time series components in the data:

1) Trend
2) Seasonality
3) Cyclical
Cyclical

- Variation in a time series sequence due to economic factors such as recession or growth; occurs over longer periods of time than a year
- Not easily predicted

Example of Cyclical Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>110</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
</tbody>
</table>

US Retail Sales (deseasonalized) (in billions of dollars)

Vocabulary

To develop an adequate forecast, one must be able to identify the four time series components in the data:

- 1) Trend
- 2) Seasonality
- 3) Cyclical
- 4) Erratic
**Erratic/Irregular**
- Random fluctuations due to chance
- Not predictable
- Outliers in the data would be an example of the erratic component

**Example of Erratic Data**

![Graph of Operating Revenues of Delta Airlines](image)

**Quiz Time**

Name the time series components in this graph.

![Graph of Retail Sales](image)
Quiz Time Answer

- All four time series components are present: upward trend, seasonality (notice the pattern every four quarters; low in the first quarter, high in the fourth quarter), cyclical (go back to the cyclical example (the data used is close to the same), and erratic (outlier—oil embargo in 1977 created a slump in retail sales).

Seasonality

- Sometimes seasonality is not easily detected by examining the time series graph.
- Alternative methods:
  1) Do decomposition in Minitab and examine the graph of the seasonal indices.
  2) Examine the list of seasonal indices.

Seasonality

- Note that seasonality is not easily detected in this graph.
Seasonality continued

- The graph of the seasonal indices shows the pattern in the data over the 12 months:
  - most revenue: May
  - least revenue: June

Seasonality continued

- Another alternative is to examine the seasonal indices.
  - If the seasonal indices are all close to 1 (at the thousandths place), then there is no seasonality.
  - If the seasonal indices fluctuate about 1 at the tenths or hundredths place, then there is seasonality.

Seasonality continued

<table>
<thead>
<tr>
<th>Period</th>
<th>Index</th>
<th>Period</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>1</td>
<td>1.00168</td>
</tr>
<tr>
<td>2</td>
<td>0.91178</td>
<td>2</td>
<td>0.99930</td>
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<td>3</td>
<td>0.97219</td>
<td>3</td>
<td>0.99354</td>
</tr>
<tr>
<td>4</td>
<td>0.87616</td>
<td>4</td>
<td>1.00548</td>
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<tr>
<td>5</td>
<td>1.51686</td>
<td>6</td>
<td>0.49611</td>
</tr>
<tr>
<td>7</td>
<td>1.34893</td>
<td>7</td>
<td>1.04286</td>
</tr>
<tr>
<td>8</td>
<td>1.06286</td>
<td>8</td>
<td>1.08254</td>
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<tr>
<td>9</td>
<td>1.0254</td>
<td>9</td>
<td>0.59272</td>
</tr>
<tr>
<td>10</td>
<td>0.79806</td>
<td>10</td>
<td>0.59272</td>
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<tr>
<td>11</td>
<td>1.15262</td>
<td>11</td>
<td>0.79806</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Notice fluctuation is occurring at the thousandths place only and all numbers are exceedingly close to 1.
Using Minitab

- The directions for making a time series plot are available in two forms:
  1) view the video clip here and/or
  2) print the step-by-step directions available under handouts