

DIRECTIONS:

- Some of the exercises listed below include special instructions which modify or clarify textbook instructions.
 - Data files for some exercises are found on the MINITAB Data Sets link from the course website.
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(More Practice With Trend Forecasts)

A. Cable Wire Sales

In the last problem of HW10 (Problem E: Chinese Car Ownership), we fit a trend to the time series where the residuals from the trend fit are *autocorrelated*. In that problem we improved on trend forecasts for future Chinese car ownership by forecasting the residuals, as well.

But can you guess how to obtain valid 95% forecasts when the residuals from the trend fit are not autocorrelated?

The data file `Wire` shows U.S. sales (in thousands of feet) of a special flat cable wire used in heavy equipment such as cranes and hoists, from January 2005 through December 2007.

- (a) Make a time-series plot. Do sales appear to follow a linear trend?
- (b) Fit a linear trend to the series by simple linear regression.
 - Which variable is the predictor variable?
 - What is R^2 from this regression?
- (c) Consider the sample or fitted regression equation. Interpret the slope from this equation.
- (d) Run the regression again, this time storing the residuals in the MINITAB worksheet. Make a time-series plot of the residuals. Add a “0 line” by right-clicking inside the plot and Add the Reference Line $Y = 0$.

Apply the Runs Test in MINITAB and answer the following:

- Write down the hypotheses H_0 and H_A in words.
- What is the P -value?
- What is the conclusion?

(continued)

(e) Interpret a 95% forecast for cable wire sales in March 2008.

(f) Is it necessary to forecast residuals? Why or why not?

(Seasonal Forecasts)

B. Retail Trade Employment

DIRECTIONS:

- Open the `Trade Employment` data file and refer to page 37 in the Topic 11 Notes.
- First make a plot:
Stat > Time Series > Time Series Plot > (Select Trade Employment) > OK
- Now improve the plot by showing the actual dates along the horizontal axis:
(Click the “blue box” – i.e., recall previous commands) > Time/Scale > Stamp
> (Select Date) > OK > OK
- Clearly, these data show both a *trend* and *seasonality*. The first step is to model the trend with simple regression. So make a Fitted Line Plot and also get the full regression output for `Trade vs. Month`, as shown on page 38 in the Topic 11 Notes.
- To see the autocorrelation of residual errors from simple regression, rerun
Regression ... Regression
and store the residuals in the MINITAB worksheet:
Storage > (Select Residuals) > OK > OK
- Now make a scatterplot of Residuals vs. Month:
Graph > Scatterplot ...
- Since this is a *time series* we should connect the dots to reproduce Figure 2:
Graph > Scatterplot > With Connect Line > OK ...
Just for fun add a horizontal line to the graph to separate *positive* residuals from *negative* residuals:
(Right-click inside the graph) > Add > Reference Lines > $Y = 0$ > OK

Answer these questions using the Trend-Only model:

- (a) Use Options in MINITAB regression to predict trade employment in March 1976.
- (b) Predict trade employment in March 1976 with 95% certainty.

Note: The textbook exercises below require indicator variables to represent seasonality in *quarterly* data. To do this, you can simply enter 1's and 0's by hand in three new columns:

$$\begin{aligned}
 x_1 &= \begin{cases} 1 & \text{for first quarter} \\ 0 & \text{otherwise} \end{cases} \\
 x_2 &= \begin{cases} 1 & \text{for second quarter} \\ 0 & \text{otherwise} \end{cases} \\
 x_3 &= \begin{cases} 1 & \text{for third quarter} \\ 0 & \text{otherwise} \end{cases}
 \end{aligned}$$

| Quarter | x_1 | x_2 | x_3 |
|---------|-------|-------|-------|
| 1 | 1 | 0 | 0 |
| 2 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 |
| 4 | 0 | 0 | 0 |

With this setup, the three seasonal coefficients always compare to the *fourth* quarter.

C. JCPenny Retail Sales (Note: You may need your own scratch paper for these exercises.)

- As an introduction, read pages 750–753 and 756-757 in the textbook.
- Exercise 13.1 (p. 752)
 - (b) Use a MINITAB Time Series Plot with the Time/Scale option to put actual dates on the horizontal axis.
- Exercise 13.3 (p. 756)
- Exercise 13.5 (p. 758)

After you add the three dummy variables for Quarters 1–3, your MINITAB worksheet should look like this:

| Order | Year-Quarter | Sales | Q1 | Q2 | Q3 |
|-------|--------------|-------|----|----|----|
| 1 | 1996-1st | 4452 | 1 | 0 | 0 |
| 2 | 1996-2nd | 4507 | 0 | 1 | 0 |
| 3 | 1996-3rd | 5537 | 0 | 0 | 1 |
| 4 | 1996-4th | 8157 | 0 | 0 | 0 |
| 5 | 1997-1st | 6481 | 1 | 0 | 0 |
| 6 | 1997-2nd | 6420 | 0 | 1 | 0 |
| 7 | 1997-3rd | 7208 | 0 | 0 | 1 |
| 8 | 1997-4th | 9509 | 0 | 0 | 0 |
| 9 | 1998-1st | 6755 | 1 | 0 | 0 |
| 10 | 1998-2nd | 6483 | 0 | 1 | 0 |
| 11 | 1998-3rd | 7129 | 0 | 0 | 1 |
| 12 | 1998-4th | 9072 | 0 | 0 | 0 |
| 13 | 1999-1st | 7339 | 1 | 0 | 0 |
| 14 | 1999-2nd | 7104 | 0 | 1 | 0 |
| 15 | 1999-3rd | 7639 | 0 | 0 | 1 |
| 16 | 1999-4th | 9661 | 0 | 0 | 0 |
| 17 | 2000-1st | 7528 | 1 | 0 | 0 |
| 18 | 2000-2nd | 7207 | 0 | 1 | 0 |
| 19 | 2000-3rd | 7538 | 0 | 0 | 1 |
| 20 | 2000-4th | 9573 | 0 | 0 | 0 |
| 21 | 2001-1st | 7522 | 1 | 0 | 0 |
| 22 | 2001-2nd | 7211 | 0 | 1 | 0 |
| 23 | 2001-3rd | 7729 | 0 | 0 | 1 |
| 24 | 2001-4th | 9542 | 0 | 0 | 0 |

- Exercise 13.15 (p. 766)
- Exercise 13.16

C. continued

- Exercise 13.19 (p. 766)
You'll need both the Trend-Only and Trend-Seasonal regression models.

Helpful Hint: Use

Storage > (Check "Fits")

to get both the Trend-Only predictions and Trend-Seasonal predictions from regression.

Then use

Time Series > Time Series Plot > Multiple > OK

to plot the three time series together, as requested in part (c).

- Exercise 13.23
Do part (a) only.

- Exercise 13.24

- **Extra Exercise**

We concluded that the Trend-Seasonal model is superior to the Trend-Only model so we'll make forecasts using the Trend-Seasonal model.

Follow these steps: Store residuals from the Trend-Seasonal model. Fit an $AR(p)$ autoregression model to the residuals using MINITAB Partial Autocorrelation and ARIMA procedures.

Questions:

- (a) Find the correct value of p for the $AR(p)$ model, using 5% significance.
- (b) From MINITAB output, write down the fitted $AR(p)$ model for residuals.
- (c) Use MINITAB to make both a simple forecast and a 95% forecast for JCPenny sales in the first quarter of 2002.
- (d) Make both a simple forecast and a 95% forecast for the fourth quarter of 2002.
- (e) Make both a simple forecast and a 95% forecast for the third quarter of 2003.
- (f) Explain why it makes sense for the residual forecasts \hat{e}_t for the JCPenny data to be negative numbers.
- (g) Statistically speaking, is it easier or harder to forecast sales for the third quarter of 2003 compared to the fourth quarter of 2002? Cite numerical evidence to support your answer.

(Seasonal Factors and Deseasonalized Data)

C. continued

DIRECTIONS: Review our work with *seasonal factors* and *deseasonalized data* for the Trade Employment example on pages 51–58 in the Topic 11 Notes. Let the ideas “sink in.” ☺

- Exercise 13.7 (p. 761)

Hint for part (c): Put the four seasonal factors into a MINITAB column and make a “connected scatterplot.”

Add part (d):

(d) Use MINITAB Time Series Decomposition.

- Are MINITAB’s seasonal factors similar to the ones which you calculated in (a)? Are they identical?

 - Plot the seasonally-adjusted time series. What are seasonally-adjusted JCPenny sales in the second quarter of 1998?
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- Exercise 13.17 (p. 766)

(end of Problem C)

D. Number of Macs Shipped

- Exercise 13.2 (p. 755)

(a) Use

Stat > Time Series > Time Series Plot

and choose Fiscal Year/Qtr as the “stamp” variable in the Time/Scale option to plot actual dates on the horizontal axis.

(b) Use the calculation formulas for b_0 and b_1 of simple linear regression. (See Exam 3 formula sheet.)

(c) Hint: Use

Stat > Time Series > Trend Analysis > (Select Macs-Shipped) > OK

to make the plot.

Add part (d):

(d) How does the trend line from the MINITAB plot from (c) compare to the regression line which you computed in (b)?

- Exercise 13.4

- Exercise 13.6

Add part (d):

(d) Use MINITAB Time Series Decomposition.

- Are MINITAB’s seasonal factors similar to the ones which you calculated in (a)? Are they identical?

- Plot the seasonally-adjusted time series. What are seasonally-adjusted Mac shipments in the first quarter of 2002?

(end of assignment)