12. If the seasonal index for January is 0.80, then
    a. January sales tend to be 80% higher than an average month.
    b. January sales tend to be 20% higher than an average month.
    c. January sales tend to be 80% lower than an average month.
    d. January sales tend to be 20% lower than an average month.
13. If both trend and seasonal components are present in a time series, then the seasonal indices
    a. should be computed based on an overall average.
    b. should be computed based on CMAs.
    c. will all be greater than 1.
    d. should be ignored in developing the forecast.
14. Which of the following is used to alert the user of a forecasting model that a significant error occurred in one of the periods?
    a. a seasonal index
    b. a smoothing constant
    c. a tracking signal
    d. a regression coefficient
15. If the multiplicative decomposition model is used to forecast daily sales for a retail store, how many seasons will there be?
    a. 4
    b. 7
    c. 12
    d. 365

Discussion Questions and Problems

Discussion Questions

5-1 Describe briefly the steps used to develop a forecasting system.

5-2 What is a time-series forecasting model?

5-3 What is the difference between a causal model and a time-series model?

5-4 What is a qualitative forecasting model, and when is it appropriate?

5-5 What are some of the problems and drawbacks of the moving average forecasting model?

5-6 What effect does the value of the smoothing constant have on the weight given to the past forecast and the past observed value?

5-7 Describe briefly the Delphi technique.

5-8 What is MAD, and why is it important in the selection and use of forecasting models?

5-9 Explain how the number of seasons is determined when forecasting with a seasonal component.

5-10 A seasonal index may be less than one, equal to one, or greater than one. Explain what each of these values would mean.

5-11 How is the impact of seasonality removed from a time series?

5-12 In using the decomposition method, the forecast based on trend is found using the trend line. How is the seasonal index used to adjust this forecast based on trend?

5-13 Explain what would happen if the smoothing constant in an exponential smoothing model was equal to zero. Explain what would happen if the smoothing constant was equal to one.

5-14 Explain when a CMA (rather than an overall average) should be used in computing a seasonal index. Explain why this is necessary.

Problems

5-15 Develop a 4-month moving average forecast for Wallace Garden Supply, and compute the MAD. A 3-month moving average forecast was developed in the section on moving averages in Table 5.2.

5-16 Using MAD, determine whether the forecast in Problem 5-15 or the forecast in the section concerning Wallace Garden Supply is more accurate.

5-17 Data collected on the yearly demand for 50-pound bags of fertilizer at Wallace Garden Supply are shown in the following table. Develop a 3-year moving average to forecast sales. Then estimate demand again with a weighted moving average in which sales in the most recent year are given a weight of 2 and sales in the other 2 years are each given a weight of 1. Which method do you think is better?

YEAR	DEMAND FOR FERTILIZER (1,000s OF BAGS)
1	4
2	6
3	4
4	5
5	10
6	8
7	7

(*Continued on next page*)

Note: means the problem may be solved with QM for Windows; means the problem may be solved with Excel QM; and means the problem may be solved with QM for Windows and/or Excel QM.

TABLE 5.2
Wallace Garden Supply Shed Sales

MONTH	ACTUAL SHED SALES	3-MONTH MOVING AVERAGE
January	10	
February	12	
March	13	
April	16	$(10 + 12 + 13)/3 = 11.67$
May	19	$(12 + 13 + 16)/3 = 13.67$
June	23	$(13 + 16 + 19)/3 = 16.00$
July	26	$(16 + 19 + 23)/3 = 19.33$
August	30	$(19 + 23 + 26)/3 = 22.67$
September	28	$(23 + 26 + 30)/3 = 26.33$
October	18	$(26 + 30 + 28)/3 = 28.00$
November	16	$(30 + 28 + 18)/3 = 25.33$
December	14	$(28 + 18 + 16)/3 = 20.67$
January	—	$(18 + 16 + 14)/3 = 16.00$

Wallace Garden Supply decides to use a 3-month weighted moving average forecast with weights of 3 for the most recent observation, 2 for the next observation, and 1 for the most distant observation. This would be implemented as follows:

WEIGHT APPLIED	PERIOD
3	Last month
2	2 months ago
1	3 months ago

③ × Sales last month + ② × Sales 2 months ago + ① × Sales 3 months ago

⑥ Sum of the weights

The results of the Wallace Garden Supply weighted average forecast are shown in Table 5.3. In this particular forecasting situation, you can see that weighting the latest month more heavily provides a much more accurate projection, and calculating the MAD for each of these would verify this.

Choosing the weights obviously has an important impact on the forecasts. One way to choose weights is to try various combinations of weights, calculate the MAD for each, and select the set of weights that results in the lowest MAD. Some forecasting software has an option to search for the best set of weights, and forecasts using these weights are then provided. The best set of weights can also be found by using nonlinear programming, as will be seen in a later chapter.

Some software packages require that the weights add to 1, and this would simplify Equation 5-7 because the denominator would be 1. Forcing the weights to sum to 1 is easily achieved by dividing each of the weights by the sum of the weights. In the Wallace Garden Supply example in Table 5.3, the weights are 3, 2, and 1, which add to 6. These weights could be revised to the new weights 3/6, 2/6, and 1/6, which add to 1. Using these weights gives the same forecasts shown in Table 5.3.

Moving averages have two problems: the larger number of periods may smooth out real changes, and they don't pick up trends.

Both simple and weighted moving averages are effective in smoothing out sudden fluctuations in the demand pattern in order to provide stable estimates. Moving averages do, however, have two problems. First, increasing the size of n (the number of periods averaged) does smooth out fluctuations better, but it makes the method less sensitive to *real* changes in the data, should they occur. Second, moving averages cannot pick up trends very well. Because they are averages, they will always stay within past levels and will not predict a change to either a higher or a lower level.

YEAR	DEMAND FOR FERTILIZER (1,000s OF BAGS)
8	9
9	12
10	14
11	15

• 5-18 Develop a trend line for the demand for fertilizer in Problem 5-17, using any computer software.

5-19 In Problems 5-17 and 5-18, three different forecasts were developed for the demand for fertilizer. These three forecasts are a 3-year moving average, a weighted moving average, and a trend line. Which one would you use? Explain your answer.

5-20 Use exponential smoothing with a smoothing constant of 0.3 to forecast the demand for fertilizer given in Problem 5-17. Assume that last period's forecast for year 1 is 5,000 bags to begin the procedure. Would you prefer to use the exponential smoothing model or the weighted average model developed in Problem 5-17? Explain your answer.

5-21 A college student has just completed her junior year. The following table summarizes her grade-point average (GPA) for each of the past nine quarters:

YEAR	SEMESTER	GPA
Freshman	Fall	2.4
	Winter	2.9
	Spring	3.1
Sophomore	Fall	3.2
	Winter	3.0
	Spring	2.9
Junior	Fall	2.8
	Winter	3.6
	Spring	3.2

(a) Forecast the student's GPA for the fall semester of her senior year by using a three-period moving average.
(b) Forecast the student's GPA for the fall semester of her senior year by using exponential smoothing with $\alpha = 0.2$.
(c) Which of the two methods provides a more accurate forecast? Justify your answer.

5-22 Sales of Cool-Man air conditioners have grown steadily during the past 5 years:

YEAR	SALES	YEAR	SALES
1	450	4	563
2	495	5	584
3	518	6	?

The sales manager had predicted, before the business started, that year 1's sales would be 410 air conditioners. Using exponential smoothing with a weight of $\alpha = 0.30$, develop forecasts for years 2 through 6.

• 5-23 Using smoothing constants of 0.6 and 0.9, develop forecasts for the sales of Cool-Man air conditioners (see Problem 5-22).

5-24 What effect did the smoothing constant have on the forecast for Cool-Man air conditioners? (See Problems 5-22 and 5-23.) Which smoothing constant gives the more accurate forecast?

• 5-25 Use a 3-year moving average forecasting model to forecast the sales of Cool-Man air conditioners (see Problem 5-22).

• 5-26 Using the trend projection method, develop a forecasting model for the sales of Cool-Man air conditioners (see Problem 5-22).

5-27 Would you use exponential smoothing with a smoothing constant of 0.3, a 3-year moving average, or a trend line to predict the sales of Cool-Man air conditioners? Refer to Problems 5-22, 5-25, and 5-26.

5-28 Sales of industrial vacuum cleaners at R. Lowenthal Supply Co. over the past 13 months are as follows:

SALES ($1,000s)	MONTH	SALES ($1,000s)	MONTH
11	January	14	August
14	February	17	September
16	March	12	October
10	April	14	November
15	May	16	December
17	June	11	January
11	July		

(a) Using a moving average with three periods, determine the demand for vacuum cleaners for next February.
(b) Using a weighted moving average with three periods, determine the demand for vacuum cleaners for February. Use 3, 2, and 1 for the weights of the most recent, second most recent, and third most recent periods, respectively. For example, if you were forecasting the demand for February, November would have a weight of 1, December would have a weight of 2, and January would have a weight of 3.
(c) Evaluate the accuracy of each of these methods.
(d) What other factors might R. Lowenthal consider in forecasting sales?

5-29 Passenger miles flown on Northeast Airlines, a commuter firm serving the Boston hub, are as follows for the past 12 weeks:

WEEK	ACTUAL PASSENGER MILES (1,000s)	WEEK	ACTUAL PASSENGER MILES (1,000s)
1	17	7	20
2	21	8	18
3	19	9	22
4	23	10	20
5	18	11	15
6	16	12	22

(a) Assuming an initial forecast for week 1 of 17,000 miles, use exponential smoothing to compute miles for weeks 2 through 12. Use $\alpha = 0.2$.
(b) What is the MAD for this model?
(c) Compute the RSFE and tracking signals. Are they within acceptable limits?

5-30 Emergency calls to Winter Park, Florida's 911 system for the past 24 weeks are as follows:

WEEK	CALLS	WEEK	CALLS	WEEK	CALLS
1	50	9	35	17	55
2	35	10	20	18	40
3	25	11	15	19	35
4	40	12	40	20	60
5	45	13	55	21	75
6	35	14	35	22	50
7	20	15	25	23	40
8	30	16	55	24	65

(a) Compute the exponentially smoothed forecast of calls for each week. Assume an initial forecast of 50 calls in the first week, and use $\alpha = 0.1$. What is the forecast for week 25?
(b) Reforecast each period using $\alpha = 0.6$.
(c) Actual calls during week 25 were 85. Which smoothing constant provides a superior forecast?

5-31 How would the forecast for week 25 of the previous problem change if the initial forecast was 40 instead of 50? How would the forecast for week 25 change if the forecast for week 1 was assumed to be 60?

5-32 Sales of vacuum cleaners over the past 13 months were as follows:

MONTH	SALES	MONTH	SALES
January	9	July	9
February	12	August	12
March	14	September	15
April	8	October	10
May	13	November	12
June	15	December	14

(a) Using a moving average with three periods, predict the demand for vacuum cleaners for next February.
(b) Using a three-period weighted moving average with weights 3, 2, and 1, predict the demand for vacuum cleaners for February.
(c) Evaluate and comment on the accuracy of each of these models.

5-33 Consulting income at Kate Walsh Associates for the period February–July has been as follows:

MONTH	INCOME ($1,000s)
February	70.0
March	68.5
April	64.8
May	71.7
June	71.3
July	72.8

Use exponential smoothing to forecast August's income. Assume that the initial forecast for February is $65,000. The smoothing constant selected is $\alpha = 0.1$.

5-34 Resolve Problem 5-33 with $\alpha = 0.3$. Using MAD, which smoothing constant provides a better forecast?

5-35 A major source of revenue in Texas is a state sales tax on certain types of goods and services. Data are compiled, and the state comptroller uses them to project future revenues for the state budget. One particular category of goods is classified as Retail Trade. Four years of quarterly data (in $1,000,000s) for one particular area of southeast Texas follow:

QUARTER	YEAR 1	YEAR 2	YEAR 3	YEAR 4
1	218	225	234	250
2	247	254	265	283
3	243	255	264	289
4	292	299	327	356

(a) Compute a seasonal index for each quarter based on a CMA.
(b) Deseasonalize the data, and develop a trend line on the deseasonalized data.
(c) Use the trend line to forecast the sales for each quarter of year 5.
(d) Use the seasonal indices to adjust the forecasts found in part (c) to obtain the final forecasts.

5-36 Using the data in Problem 5-35, develop a multiple regression model to predict sales (with both trend and seasonal components), using dummy variables to incorporate the seasonal factor into the model. Use this model to predict sales for each quarter of the next year. Comment on the accuracy of this model.

5-37 Trevor Harty, an avid mountain biker, always wanted to start a business selling top-of-the-line mountain

bikes and other outdoor supplies. A little over 6 years ago, he and a silent partner opened a store called Hale and Harty Trail Bikes and Supplies. Growth was rapid in the first 2 years, but since that time, growth in sales has slowed a bit, as expected. The quarterly sales (in $1,000s) for the past 4 years are shown in the table below:

QUARTER	YEAR 1	YEAR 2	YEAR 3	YEAR 4
1	274	282	282	296
2	172	178	182	210
3	130	136	134	158
4	162	168	170	182

(a) Develop a trend line using the data in the table. Use this to forecast sales for each quarter of year 5. What does the slope of this line indicate?

(b) Use the multiplicative decomposition model to incorporate both trend and seasonal components into the forecast. What does the slope of this line indicate?

(c) Compare the slope of the trend line in part (a) to the slope in the trend line for the decomposition model that was based on the deseasonalized sales figures. Discuss why these are so different and explain which is the better one to use.

5-38 The unemployment rates in the United States during a 10-year period are given in the following table. Use exponential smoothing to find the best forecast for next year. Use smoothing constants of 0.2, 0.4, 0.6, and 0.8. Which one had the lowest MAD?

YEAR	1	2	3	4	5	6	7	8	9	10
Unemployment rate (%)	7.2	7.0	6.2	5.5	5.3	5.5	6.7	7.4	6.8	6.1

5-39 Management of Davis's Department Store has used time-series extrapolation to forecast retail sales for the next four quarters. The sales estimates are $100,000, $120,000, $140,000, and $160,000 for the respective quarters before adjusting for seasonality. Seasonal indices for the four quarters have been found to be 1.30, 0.90, 0.70, and 1.10, respectively. Compute a seasonalized or adjusted sales forecast.

5-40 In the past, Judy Holmes's tire dealership sold an average of 1,000 radials each year. In the past 2 years, 200 and 250, respectively, were sold in fall, 350 and 300 in winter, 150 and 165 in spring, and 300 and 285 in summer. With a major expansion planned, Judy projects sales next year to increase to 1,200 radials. What will the demand be each season?

5-41 The following table provides the Dow Jones Industrial Average (DJIA) opening index value on the first working day of 1994–2013. Develop a trend line and use it to predict the opening DJIA index value for years 2014, 2015, and 2016. Find the MSE for this model.

YEAR	DJIA	YEAR	DJIA
2013	13,104	2003	8,342
2012	12,392	2002	10,022
2011	11,577	2001	10,791
2010	10,431	2000	11,502
2009	8,772	1999	9,213
2008	13,262	1998	7,908
2007	12,460	1997	6,448
2006	10,718	1996	5,117
2005	10,784	1995	3,834
2004	10,453	1994	3,754

5-42 Using the DJIA data in Problem 5-41 and exponential smoothing with trend adjustment, forecast the opening DJIA value for 2014. Use $\alpha = 0.8$ and $\beta = 0.2$. Compare the MSE for this technique with the MSE for the trend line.

5-43 Refer to the DJIA data in Problem 5-41.

(a) Use an exponential smoothing model with a smoothing constant of 0.4 to predict the opening DJIA index value for 2014. Find the MSE for this.

(b) Use QM for Windows or Excel to find the smoothing constant that would provide the lowest MSE.

5-44 The following table gives the average monthly exchange rate between the U.S. dollar and the euro for 2009. It shows that 1 euro was equivalent to 1.289 U.S. dollars in January 2009. Develop a trend line that could be used to predict the exchange rate for 2010. Use this model to predict the exchange rate for January 2010 and February 2010.

MONTH	EXCHANGE RATE
January	1.289
February	1.324
March	1.321
April	1.317
May	1.280
June	1.254
July	1.230
August	1.240
September	1.287
October	1.298
November	1.283
December	1.311

5-45 For the data in Problem 5-44, develop an exponential smoothing model with a smoothing constant of 0.3. Using the MSE, compare this with the model in Problem 5-44.