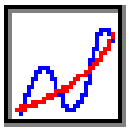
Solutions to Worktext Exercises



Chapter 20

Visualizing Trends and Seasonality

Basic Learning Exercises

1. It is a cyclical industry that goes through periods of growth and decline.

2. R^2 0.93 to 0.97 MSE 150 to 300 MAPE 8 to 12
Yes, it would give reasonable short-run forecasts. However, cubic trends may not work well over a longer time horizon.

3. R^2 0.60 to 0.85 MSE 800 to 2,500 MAPE 20 to 40
Occasionally, the MAPE will be well over 100 when an observed value is near zero.

4. When random error increases, the fit is generally worse. A better fit is shown by larger R^2, smaller MSE, and smaller MAPE.

5. R^2 0.50 to 0.75 MSE 1,300 to 3,300 MAPE 47 to 70
The fit is worse (R^2 decreased and both MSE and MAPE increased). No, the quadratic trend would give unreasonable short-run forecasts (negative shipments make no sense).

6. R^2 0.02 to 0.35 MSE 280,000 to 700,000 MAPE 26 to 60
Short term forecasts would probably be too high, because the data are non-linear. A product that was a rage and then a bust (e.g., Trivial Pursuit or Transformers).

7. Quadratic: R^2 0.15 to 0.50 MSE 280,000 to 650,000 MAPE 20 to 40
Cubic: R^2 0.23 to 0.50 MSE 280,000 to 500,000 MAPE 20 to 40
When using the quadratic or cubic model, R^2 increases a little, MSE has a smaller range, and MAPE decreases a little. Although the improvement in fit is slight, a case can be made for using the quadratic trend model because the data are non-linear. The cubic's slightly better fit does not justify its added complexity.

8. When an additional term is added to a polynomial model (even if it is an incorrect model) the fit can only improve (as measured by R^2 or MSE). But polynomial models (e.g., cubic) are hard to interpret, and simpler models are used whenever possible.

9. 8 years: R^2 0.20 to 0.45 MSE 300,000 to 500,000 MAPE 25 to 45
3 years: R^2 0.15 to 0.55 MSE 175,000 to 600,000 MAPE 15 to 55
The fit statistics are more variable when sample size is small. However, it may be difficult to make this generalization based only on 10 samples.

10. In general, larger samples are preferred. No, it is not a good idea to use all 8 years. More data is only a good idea if the model has not changed. It is unlikely that the same times series model would be appropriate during both peace and war years.

Intermediate Learning Exercises

11. The trend is accelerating growth. The true model is exponential, but any of the three nonlinear models might seem acceptable. The linear model is too low at each end. All the models yield about the same R^2, but this statistic is less sensitive than the eye.

12. It is almost perfect because there is no random error. No, a complete absence of random error is unrealistic.

13. In many months the estimated seasonality is very close to the true seasonality. It is probably wider than expected. About four of the 12 intervals contain 0. This means that for those months, seasonality is not statistically different from 0.

14. a) In some months, the estimated model is close to the true model, while in other months it is inaccurate. The confidence intervals are much longer. b) Depending on the sample, about 8 of the confidence intervals will contain 0, indicating that seasonality is not statistically different from 0. c) More intervals contain 0 because of increased error.

15. The greater the random error, the more difficult it is to estimate seasonality.

16. It appears jagged, not smooth, because the seasonality is over just four periods. Yes, it resembles the true model.

17. The fitted model (magenta) resembles the true model (cyan) in a general way. But the four seasonal estimates generally are quite poor (the red bars do not give a good estimate of the blue bars, and the confidence intervals are wide for most quarters).

18. The seasonal estimates are much more accurate. Most of the red bars are similar to the blue bars, and the confidence intervals are narrower, indicating that the estimated seasonal factors are accurate.

19. Most of the estimates are mediocre. The confidence intervals are long, and many of the red bars do not closely resemble the blue bars.

20. When estimating seasonality with monthly data you are estimating 12 seasonal factors, while with quarterly data you are estimating only 4 factors. Hence, your seasonal estimates with quarterly data are based on 15 quarters (60/4), while with monthly data they are based on 5 months (60/12). This is similar to using 5 years of quarterly data.

Advanced Learning Exercises

21. The fitted model (magenta) resembles the true model (cyan). The magnitude of seasonality increases as Y and time increase. This is a multiplicative model, so the magnitude of seasonality increases as the trend increases.

22. The magnitude of seasonality decreases as Y decreases and as time increases.

23. The magnitude of seasonality is constant because Y has no trend.

24. In a multiplicative model, seasonal variation is *proportional* to the value of Y. For example, July sales of ice cream might be 150% of the trend, while in January sales might be 50% of the trend. This is common in many business situations.

25. Multiplicative seasonality is more easily estimated, other things being equal, because seasonality is a constant percentage of Y, rather than being a fixed number. With additive seasonality, a given seasonal variation is a large percentage if Y is small and is a smaller percentage if Y is large.

26. Trend is the slope, Growth is the coefficient of t^2, and Acceleration is the coefficient of t^3 in the cubic model $Y = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3$.

27. Full negative Trend and positive Growth. Full positive Trend and negative Growth. One click of Trend (past zero), full negative Growth, and full positive Acceleration.

28. At 0.7 the function decreases quickly and is asymptotic to 0. 0. As it approaches 1.0, the function decreases to 0.0 more slowly. At 1.0 it is always equal to its intercept. As the parameter increases past 1.0, the function increases asymptotically from the intercept.

29. It means that the function is growing at 5% per year, per quarter, or per month. It is reasonable for annual salary, but is unlikely for monthly salary.

30. Many answers are possible. To obtain a U-shaped curve, use any intercept, a t coefficient of –3000, a coefficient of t^2 of 60, and a coefficient of t^3 of 0.0. To obtain an upside-down U-shaped curve, negate the parameter values in the first part. To obtain an equation with a peak followed by a trough, use any intercept, a coefficient of t of –3000, a coefficient of t^2 of –120, and a coefficient of t^3 of 1.42.

31. In order to create a special situation that is not covered by the 15 templates.