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Chapter FORECASTING Discussion Questions 1.? Qualitative models incorporate subjective factors into the forecasting model. Qualitative models are useful when subjective factors are important. When quantitative data are difficult to obtain, qualitative models may be appropriate. 2.? Approaches are qualitative and quantitative. Qualitative is relatively subjective; quantitative uses numeric models. 3.? Short-range (under 3 months), medium-range (3 months to 3 years), and long-range (over 3 years). 4.? The steps that should be used to develop a forecasting system are: (a)?

Determine the purpose and use of the forecast (b)? Select the item or quantities that are to be forecasted (c)? Determine the time horizon of the forecast (d)? Select the type of forecasting model to be used (e)? Gather the necessary data (f)? Validate the forecasting model (g)? Make the forecast (h)? Implement and evaluate the results 5.? Any three of: sales planning, production planning and budgeting, cash budgeting, analyzing various operating plans. 6.? There is no mechanism for growth in these models; they are built exclusively from historical demand values. Such methods will always lag trends. .? Exponential smoothing is a weighted moving average where all previous values are weighted with a set of weights that decline exponentially. 8.? MAD, MSE, and MAPE are common measures of forecast accuracy. To find the more accurate forecasting model, forecast with each tool for several periods where the demand outcome is known, and calculate MSE, MAPE, or MAD for each. The smaller error indicates the better forecast. 9.? The Delphi technique involves: (a)? Assembling a group of experts in such a manner as to preclude direct communication between identifiable members of the group (b)?

Assembling the responses of each expert to the questions or problems of interest (c)? Summarizing these responses (d)? Providing each expert with the summary of all responses (e)? Asking each expert to study the summary of the responses and respond again to the questions or problems of interest. (f)? Repeating steps (b) through (e) several times as necessary to obtain convergence in responses. If convergence has not been obtained by the end of the fourth cycle, the responses at that time should probably be accepted and the process terminated—little additional convergence is likely if the process is continued. 0.? A time series model predicts on the basis of the assumption that the future is a function of the past, whereas an associative model incorporates into the model the variables of factors that might influence the quantity being forecast. 11.? A time series is a sequence of evenly spaced data points with the four components of trend, seasonality, cyclical, and random variation. 12.? When the smoothing constant, (, is large (close to 1. 0), more weight is given to recent data; when (is low (close to 0. 0), more weight is given to past data. 13.? Seasonal patterns are of fixed duration and repeat regularly.

Cycles vary in length and regularity. Seasonal indices allow “ generic” forecasts to be made specific to the month, week, etc. , of the application. 14.? Exponential smoothing weighs all previous values with a set of weights that decline exponentially. It can place a full weight on the most recent period (with an alpha of 1. 0). This, in effect, is the naive approach, which places all its emphasis on last period’s actual demand. 15.? Adaptive forecasting refers to computer monitoring of tracking signals and self-adjustment if a signal passes its present limit. 16.?

Tracking signals alert the user of a forecasting tool to periods in which the forecast was in significant error. 17.? The correlation coefficient measures the degree to which the independent and dependent variables move together. A negative value would mean that as X increases, Y tends to fall. The variables move together, but move in opposite directions. 18.? Independent variable (x) is said to explain variations in the dependent variable (y). 19.? Nearly every industry has seasonality. The seasonality must be filtered out for good medium-range planning (of production and inventory) and performance evaluation. 20.? There are many examples.

Demand for raw materials and component parts such as steel or tires is a function of demand for goods such as automobiles. 21.? Obviously, as we go farther into the future, it becomes more difficult to make forecasts, and we must diminish our reliance on the forecasts. Ethical Dilemma This exercise, derived from an actual situation, deals as much with ethics as with forecasting. Here are a few points to consider: ¦ No one likes a system they don’t understand, and most college presidents would feel uncomfortable with this one. It does offer the advantage of depoliticizing the funds al-location if used wisely and fairly.

But to do so means all parties must have input to the process (such as smoothing constants) and all data need to be open to everyone. ¦ The smoothing constants could be selected by an agreed-upon criteria (such as lowest MAD) or could be based on input from experts on the board as well as the college. ¦ Abuse of the system is tied to assigning alphas based on what results they yield, rather than what alphas make the most sense. ¦

Regression is open to abuse as well. Models can use many years of data yielding one result or few years yielding a totally different forecast.

Selection of associative variables can have a major impact on results as well. Active Model Exercises* ACTIVE MODEL 4. 1: Moving Averages 1.? What does the graph look like when n = 1? The forecast graph mirrors the data graph but one period later. 2.? What happens to the graph as the number of periods in the moving average increases? The forecast graph becomes shorter and smoother. 3.? What value for n minimizes the MAD for this data? n = 1 (a naive forecast) ACTIVE MODEL 4. 2: Exponential Smoothing 1.? What happens to the graph when alpha equals zero? The graph is a straight line.

The forecast is the same in each period. 2.? What happens to the graph when alpha equals one? The forecast follows the same pattern as the demand (except for the first forecast) but is offset by one period. This is a naive forecast. 3.? Generalize what happens to a forecast as alpha increases. As alpha increases the forecast is more sensitive to changes in demand. *Active Models 4. 1, 4. 2, 4. 3, and 4. 4 appear on our Web site, www. pearsonhighered. com/heizer. 4.? At what level of alpha is the mean absolute deviation (MAD) minimized? alpha = . 16 ACTIVE MODEL 4. 3: Exponential Smoothing with Trend Adjustment .? Scroll through different values for alpha and beta. Which smoothing constant appears to have the greater effect on the graph? alpha 2.? With beta set to zero, find the best alpha and observe the MAD. Now find the best beta. Observe the MAD. Does the addition of a trend improve the forecast? alpha = . 11, MAD = 2. 59; beta above . 6 changes the MAD (by a little) to 2. 54. ACTIVE MODEL 4. 4: Trend Projections

1.? What is the annual trend in the data? 10. 54 2.? Use the scrollbars for the slope and intercept to determine the values that minimize the MAD. Are these the same values that regression yields?

No, they are not the same values. For example, an intercept of 57. 81 with a slope of 9. 44 yields a MAD of 7. 17. End-of-Chapter Problems [pic] (b) | | | Weighted | | Week of | Pints Used | Moving Average | | August 31 | 360 | | | September 7 | 389 | 381 (. 1 = ? 38. 1 | | September 14 | 410 | 368 (. 3 = 110. 4 | | September 21 | 381 | 374 (. 6 = 224. 4 | | September 28 | 368 | 372. | | October 5 | 374 | | | | Forecast 372. 9 | | (c) | | | | Forecasting | Error | | | Week of | Pints | Forecast | Error |(. 20 | Forecast| | August 31 | 360 | 360 | 0 | 0 | 360 | | September 7 | 389 | 360 | 29 | 5. 8 | 365. 8 | | September 14 | 410 | 365. 8 | 44. 2 | 8. 84 | 374. 64 | | September 21 | 381 | 374. 64 | 6. 36 | 1. 272 | 375. 12 | | September 28 | 368 | 375. 912 |–7. 912 |–1. 5824 | 374. 3296| | October 5 | 374 | 374. 3296 |–. 3296 |–. 06592 | 374. 2636| The forecast is 374. 26. (d)? The three-year moving average appears to give better results. [pic] [pic] Naive tracks the ups and downs best but lags the data by one period. Exponential smoothing is probably better because it smoothes the data and does not have as much variation. TEACHING NOTE: Notice how well exponential smoothing forecasts the naive. [pic] (c)? The banking industry has a great deal of seasonality in its processing requirements [pic] b) | | | Two-Year | | | | Year | Mileage | Moving Average | Error || Error| | | 1 | 3, 000 | | | | | | 2 | 4, 000 | | | | | | 3 | 3, 400 | 3, 500 |–100 | | 100 | | 4 | 3, 800 | 3, 700 | 100 | | 100 | | 5 | 3, 700 | 3, 600 | 100 | | 100 | | | | Totals| | 100 | | | 300 | | [pic] 4. 5? (c)? Weighted 2 year M. A. ith . 6 weight for most recent year. | Year | Mileage | Forecast | Error || Error| | | 1 | 3, 000 |

| | | | 2 | 4, 000 | | | | | 3 | 3, 400 | 3, 600 |–200 | 200 | | 4 | 3, 800 | 3, 640 | 160 | 160 | | 5 | 3, 700 | 3, 640 | 60 | 60 | | | | | | | 420 | | Forecast for year 6 is 3, 740 miles. [pic] 4. 5? (d) | | | Forecast | Error (| New | | Year | Mileage | Forecast | Error |(= . 50 | Forecast | | 1 | 3, 000 | 3, 000 |?? ? 0 |?? 0 | 3, 000 | | 2 | 4, 000 | 3, 000 | 1, 000 | 500 | 3, 500 | | 3 | 3, 400 | 3, 500 | –100 |–50 | 3, 450 | | 4 | 3, 800 | 3, 450 | 350 | 175 | 3, 625 | | 5 | 3, 700 | 3, 625 | 75 |? 38 | 3, 663 | | | | Total | 1, 325| | | | The forecast is 3, 663 miles. 4. 6 | Y Sales | X Period | X2 | XY | | January | 20 | 1 | 1 | 20 | | February | 21 | 2 | 4 | 42 | | March | 15 | 3 | 9 | 45 | | April | 14 | 4 | 16 | 56 | | May | 13 | 5 | 25 | 65 | | June | 16 | 6 | 36 | 96 | | July | 17 | 7 | 49 | 119 | | August | 18 | 8 | 64 | 144 | | September | 20 | 9 | 81 | 180 | | October | 20 | 10 | 100 | 200 | | November | 21 | 11 | 121 | 231 | | December | 23 | 12 | 144 | 276 | | Sum |?? 18 | 78 | 650 | 1, 474 | | Average |? 18. 2 | 6. 5 | | | (a) [pic] (b)? [i]? NaiveThe coming January = December = 23 [ii]? 3-month moving?? (20 + 21 + 23)/3 = 21. 33 [iii]? 6-month weighted [(0. 1 (17) + (. 1 (18) ???? + (0. 1 (20) + (0. 2 (20) ??? + (0. 2 (21) + (0. 3 (23)]/1. 0 = 20. 6 [iv]? Exponential smoothing with alpha = 0. 3 [pic] [v]? Trend? [pic] [pic] Forecast = 15. 73? +?. 38(13) = 20. 67, where next January is the 13th month. (c)? Only trend provides an equation that can extend beyond one month 4. 7? Present = Period (week) 6. a) So: where [pic])If the weights are 20, 15, 15, and 10, there will be no change in the forecast because these are the same relative weights as in part (a), i. e. , 20/60, 15/60, 15/60, and 10/60. c)If the weights are 0. 4, 0. 3, 0. 2, and 0. 1, then the forecast becomes 56. 3, or 56 patients. [pic] [pic] | Temperature | 2 day M. A. | | Error||(Error)2| Absolute |% Error | | 93 |— | — | — |— | | 94 |— | — |— |— | | 93 | 93. 5 |?? 0. 5 |? 0. 25| 100(. 5/93) | = 0. 54% | | 95 | 93. 5 |?? 1. 5 | ? 2. 25| 100(1. 5/95) | = 1. 58% | | 96 | 94. 0 |?? 2. 0 |?

4. 00| 100(2/96) | = 2. 08% | | 88 | 95. 5 |?? 7. | 56. 25| 100(7. 5/88) | = 8. 52% | | 90 | 92. 0 |?? 2. 0 |? 4. 00| 100(2/90) | = 2. 22% | | | | | 13. 5| | | 66. 75 | | | 14. 94% | MAD = 13. 5/5 = 2. 7 (d)? MSE = 66. 75/5 = 13. 35 (e)? MAPE = 14. 94%/5 = 2. 99% 4. 9? (a, b) The computations for both the two- and three-month averages appear in the table; the results appear in the figure below. [pic] (c)? MAD (two-month moving average) = . 750/10 = . 075 MAD (three-month moving average) = . 793/9 = . 088 Therefore, the two-month moving average seems to have performed better. [pic] (c)? The forecasts are about the same. [pic] 4. 12? t | Day | Actual | Forecast | | | | | Demand | Demand | | | 1 | Monday | 88 | 88 | | | 2 | Tuesday | 72 | 88 | | | 3 | Wednesday | 68 | 84 | | | 4 | Thursday | 48 | 80 | | | 5 | Friday | | 72 |(Answer | Ft = Ft–1 + ((At–1 – Ft–1) Let (= . 25. Let Monday forecast demand = 88 F2 = 88 + . 25(88 – 88) = 88 + 0 = 88 F3 = 88 + . 25(72 – 88) = 88 – 4 = 84 F4 = 84 + . 25(68 – 84) = 84 – 4 = 80 F5 = 80 + . 25(48 – 80) = 80 – 8 = 72 4. 13? (a)? Exponential smoothing, (= 0. 6: | | | Exponential | Absolute | | Year | Demand | Smoothing (= 0. | Deviation | | 1 | 45 | 41 | 4. 0 | | 2 | 50 | 41. 0 + 0. 6(45–41) = 43. 4 | 6. 6 | | 3 | 52 | 43. 4 + 0. 6(50–43. 4) = 47. 4 | 4. 6 | | 4 | 56 | 47. 4 + 0. 6(52–47. 4) = 50. 2 | 5. 8 | | 5 | 58 | 50. 2 + 0. 6(56–50. 2) = 53. 7 | 4. 3 | | 6 |? | 53. 7 + 0. 6(58–53. 7) = 56. 3 | | (= 25. 3 MAD = 5. 06 Exponential smoothing, (= 0. 9: | | | Exponential | Absolute | | Year | Demand | Smoothing (= 0. | Deviation | | 1 | 45 | 41 | 4. 0 | | 2 | 50 | 41. 0 + 0. 9(45–41) = 44. 6 | 5. 4 | | 3 | 52 | 44. 6 + 0. 9(50–44. 6) = 49. 5 | 2. 5 | | 4 | 56 | 49. 5 + 0. 9(52–49. 5) = 51. 8 | 4. 2 | | 5 | 58 | 51. 8 + 0. 9(56–51. 8) = 55. 6 | 2. 4 | | 6 |? | 55. 6 + 0. 9(58–55. 6) = 57. 8 | | (= 18. 5 MAD = 3. 7 (b)? 3-year moving average: | | | Three-Year | Absolute | | Year | Demand | Moving Average | Deviation | | 1 45 | | | | 2 | 50 | | | | 3 | 52 | | | | 4 | 56 |(45 + 50 +

52)/3 = 49 | 7 | | 5 | 58 | (50 + 52 + 56)/3 = 52. 7 | 5. 3 | | 6 |? | (52 + 56 + 58)/3 = 55. 3 | | (= 12. 3 MAD = 6. 2 (c)? Trend projection: | | | | Absolute | | Year | Demand | Trend Projection | Deviation | | 1 | 45 | 42. 6 + 3. 2 (1 = 45. 8 | 0. 8 | | 2 | 50 | 42. 6 + 3. 2 (2 = 49. 0 | 1. 0 | | 3 | 52 | 42. 6 + 3. 2 (3 = 52. 2 | 0. 2 | | 4 | 56 | 42. 6 + 3. 2 (4 = 55. 4 | 0. | | 5 | 58 | 42. 6 + 3. 2 (5 = 58. 6 | 0. 6 | | 6 |? | 42. 6 + 3. 2 (6 = 61. 8 | | (= 3. 2 MAD = 0. 64 [pic] | X | Y | XY | X2 | | 1 | 45 | 45 | 1 | | 2 | 50 | 100 | 4 | | 3 | 52 | 156 | 9 | | 4 | 56 | 224 | 16 | | 5 | 58 | 290 | 25 | Then: (X = 15, (Y = 261, (XY = 815, (X2 = 55, [pic]= 3, [pic]= 52. 2 Therefore: [pic] (d)? Comparing the results of the forecasting methodologies for parts (a), (b), and (c). | Forecast Methodology | MAD | | Exponential smoothing, (= 0. | 5. 06 | | Exponential smoothing, (= 0. 9 | 3. 7 | | 3-year moving average | 6. 2 | | Trend projection | 0. 64 | Based on a mean absolute deviation criterion, the trend projection is to be preferred over the exponential smoothing with (= 0. 6, exponential smoothing with (= 0. 9, or the 3-year moving average forecast methodologies. 4. 14 Method 1: MAD: (0. 20 + 0. 05 + 0. 05 + 0. 20)/4 = . 125 (better MSE : (0. 04 + 0. 0025 + 0. 0025 + 0. 04)/4 = . 021 Method 2: MAD: (0. 1 + 0. 20 + 0. 10 + 0. 11) / 4 = . 1275 MSE : (0. 01 + 0. 04 + 0. 01 + 0. 0121) / 4 = . 018 (better 4. 15 | | Forecast Three-Year | Absolute | | Year | Sales | Moving Average | Deviation | | 2005 | 450 | | | | 2006 | 495 | | | | 2007 | 518 | | | | 2008 | 563 |(450 + 495 + 518)/3 = 487. 7 | 75. 3 | | 2009 | 584 |(495 + 518 + 563)/3 = 525. 3 | 58. 7 | | 2010 | |(518 + 563 + 584)/3 = 555. 0 | | | | | (= 134 | | | | MAD = 67 | 4. 16 Year | Time Period X | Sales Y | X2 | XY | | 2005 | 1 | 450 | 1 | 450 | | 2006 | 2 | 495 | 4 | 990 | | 2007 | 3 | 518 | 9 | 1554 | | 2008 | 4 | 563 | 16 | 2252 | | 2009 | 5 | 584 | 25 | 2920 | | | | (= 2610| |(= 55 | |(= 8166 | [pic] [pic] | Year | Sales | Forecast Trend | Absolute

Deviation | | 2005 | 450 | 454. 8 | 4. 8 | | 2006 | 495 | 488. 4 | 6. | | 2007 | 518 | 522. 0 | 4. 0 | | 2008 | 563 | 555. 6 | 7. 4 | | 2009 | 584 | 589. 2 | 5. 2 | | 2010 | | 622. 8 | | | | | | (= 28 | | | | | MAD = 5. 6 | 4. 17 | | | Forecast Exponential | Absolute | | Year | Sales | Smoothing (= 0. 6 | Deviation | | 2005 | 450 | 410. 0 | 40. | | 2006 | 495 | 410 + 0. 6(450 – 410) = 434. 0 | 61. 0 | | 2007 | 518 | 434 + 0. 6(495 – 434) = 470. 6 | 47. 4 | | 2008 | 563 | 470. 6 + 0. 6(518 – 470. 6) = 499. 0 | 64. 0 | | 2009 | 584 | 499 + 0. 6(563 – 499) = 537. 4 | 46. 6 | | 2010 | | 537. 4 + 0. 6(584 – 537. 4) = 565. 6 | | | | | (= 259 | | | | MAD = 51. 8 | | | | Forecast Exponential | Absolute | | Year | Sales | Smoothing (= 0. | Deviation | | 2005 | 450 | 410. 0 | 40. 0 | | 2006 | 495 | 410 + 0. 9(450 – 410) = 446. 0 | 49. 0 | | 2007 | 518 | 446 + 0. 9(495 – 446) = 490. 1 | 27. 9 | | 2008 | 563 | 490. 1 + 0. 9(518 – 490. 1) = 515. 2 | 47. 8 | | 2009 | 584 | 515. 2 + 0. 9(563 – 515. 2) = 558. 2 | 25. 8 | | 2010 | | 558. 2 + 0. 9(584 – 558. 2) = 581. 4 | | | | |(= 190. 5 | | | | MAD = 38. 1 | (Refer to Solved Problem 4. 1)

For (= 0. 3, absolute deviations for 2005–2009 are 40. 0, 73. 0, 74. 1, 96. 9, 88. 8, respectively. So the MAD = 372. 8/5 = 74. 6. [pic] Because it gives the lowest MAD, the smoothing constant of (= 0. 9 gives the most accurate forecast. 4. 18? We need to find the smoothing constant (. We know in general that Ft = Ft–1 + ((At–1 – Ft–1); t = 2, 3, 4. Choose either t = 3 or t = 4 (t = 2 won’t let us find (because F2 = 50 = 50 + ((50 – 50) holds for any (). Let’s pick t = 3. Then F3 = 48 = 50 + ((42 – 50) or 48 = 50 + 42(– 50(or –2 = –8(So, . 25 = (Now we can find F5 : F5 = 50 + ((46 – 50)

F5 = 50 + 46(– 50(= 50 – 4(For (= . 25, F5 = 50 – 4(. 25) = 49 The forecast for time period 5 = 49 units. 4. 19? Trend adjusted exponential smoothing: (= 0. 1, (= 0. 2 | | | Unadjusted | | Adjusted | | | | Month | Income | Forecast | Trend | Forecast || Error|| Error2 | | February | 70. 0 | 65. 0 | 0. 0 | 65 |? 5. 0 |? 25. 0 | | March | 68. 5 | 65. 5 | 0. 1 | 65. 6 |? 2. 9 |? 8. 4 | | April | 64. 8 | 65. 9 | 0. 16 | 66. 05 |? 1. 2 |? 1. 6 | | May | 71. 7 | 65. 92 | 0. 13 | 66. 06 |? 5. 6 |? 31. 9 | | June | 71. | 66. 62 | 0. 25 | 66. 87 |? 4. 4 |? 19. 7 | | July | 72. 8 | 67. 31 | 0. 33 | 67. 64 |? 5. 2 |? 26. 6 | | August | | 68. 16 | | 68. 60 | | 24. 3| | | 113. 2| | MAD = 24. 3/6 = 4. 05, MSE = 113. 2/6 = 18. 87. Note that all numbers are rounded. Note: To use POM for Windows to solve this problem, a period 0, which contains the initial forecast and initial trend, must be added. 4. 20? Trend adjusted exponential smoothing: (= 0. 1, (= 0. 8 [pic] [pic] [pic] [pic] [pic] [pic] [pic] [pic] [pic] [pic] [pic] [pic] 4. 23? Students must determine the naive forecast for the four months.

The naive forecast for March is the February actual of 83, etc. |(a) | | Actual | Forecast || Error| ||% Error| | | | March | 101 | 120 | 19 | 100 (19/101) = 18. 81% | | | April |? 96 | 114 | 18 | 100 (18/96) ? = 18. 75% | | | May |? 89 | 110 | 21 | 100 (21/89) ? = 23. 60% | | | June | 108 | 108 |? 0 | 100 (0/108) ? = ?? 0% | | | | | | | 58 | | | 61. 16% | [pic] |(b)| | Actual | Naive || Error| ||% Error| | | | March | 101 |? 83 | 18 | 100 (18/101) = 17. 82% | | | April |? 96 | 101 |? | 100 (5/96) ? = 5. 21% | | | May |? 89 |? 96 |? 7 | 100 (7/89) ? =? 7. 87% | | | June | 108 |? 89 | 19 | 100 (19/108) = 17. 59% | | | | | | | 49| | | 48. 49% | | [pic] Naive outperforms management. (c)? MAD for the manager’s technique is 14. 5, while MAD for the naive forecast is only 12. 25. MAPEs are 15. 29% and 12. 12%, respectively. So the naive method is better. 4. 24? (a)? Graph of demand The observations obviously do not form a straight line but do tend to cluster about a straight line over the range shown. (b)? Least-squares regression: [pic] Assume Appearances X | Demand Y | X2 | Y2 | XY | | 3 | 3 | 9 | 9 | 9 | | 4 | 6 | 16 | 36 | 24 | | 7 | 7 | 49 | 49 | 49 | | 6 | 5 | 36 | 25 | 30 | | 8 | 10 | 64 | 100 | 80 | | 5 | 7 | 25 | 49 | 35 | | 9 | ? | | | | (X = 33, (Y = 38, (XY = 227, (X2 = 199, [pic]= 5. 5, [pic]= 6. 33. Therefore: [pic] The following figure shows both the data and the resulting equation: [pic] (c) If there are nine performances by Stone Temple Pilots, the estimated sales are: (d) R = . 82 is the correlation coefficient, and R2 = . 68 means 68% of the variation in sales can be explained by TV appearances. 4. 25? | Number of | | | | | | Accidents | | | | | Month |(y) | x | xy | x2 | | January | 30 | 1 | 30 | 1 | | February | 40 | 2 | 80 | 4 | | March | 60 | 3 | 180 | 9 | | April | 90 | 4 | 360 | 16 | |? Totals | | 220 | | | [pic] The regression line is y = 5 + 20x. The forecast for May (x = 5) is y = 5 + 20(5) = 105. 4. 26 | Season | Year1 | Year2 | Average | Average | Seasonal | Year3 | | | Demand | Demand | Year1(Year2 | Season | Index | Demand | | | | | Demand | Demand | | | | Fall | 200 | 250 | 225. 0 | 250 | 0. 90 | 270 | | Winter | 350 | 300 | 325. | 250 | 1. 30 | 390 | | Spring | 150 | 165 | 157. 5 | 250 | 0. 63 | 189 | | Summer | 300 | 285 | 292. 5 | 250 | 1. 17 | 351 | 4. 27 | | Winter | Spring | Summer | Fall | | 2006 | 1, 400 | 1, 500 | 1, 000 | 600 | | 2007 | 1, 200 | 1, 400 | 2, 100 | 750 | | 2008 | 1, 000 | 1, 600 | 2, 000 | 650 | | 2009 | 900 | 1, 500 | 1, 900 | 500 | | | 4, 500 | 6, 000 | 7, 000 | 2, 500 | 4. 28 | | | | | Average | | | | | | | Average | Quarterly | Seasonal | | Quarter | 2007 | 2008 | 2009 | Demand | Demand | Index | | Winter | 73 | 65 | 89 | 75. 67 | 106. 67 | 0. 709 | | Spring | 104 | 82 | 146 | 110. 67 | 106. 67 | 1. 037 | | Summer | 168 | 124 | 205 | 165. 67 | 106. 67 | 1. 553 | | Fall | 74 | 52 | 98 | 74. 67 | 106. 67 | 0. 700 | 4. 29? 2011 is 25 years beyond 1986. Therefore, the 2011 quarter numbers are 101 through 104. | | | | |(5) | | |(2) |(3) |(4) | Adjusted | |(1) | Quarter | Forecast | Seasonal | Forecast | | Quarter | Number |(77 + . 3Q) |

Factor |[(3) ((4)] | | Winter | 101 | 120. 43 | . 8 | 96. 344 | | Spring | 102 | 120. 86 | 1. 1 | 132. 946 | | Summer | 103 | 121. 29 | 1. 4 | 169. 806 | | Fall | 104 | 121. 72 | . 7 | 85. 204 | 4. 30? Given Y = 36 + 4. 3X (a) Y = 36 + 4. 3(70) = 337 (b) Y = 36 + 4. 3(80) = 380 (c) Y = 36 + 4. 3(90) = 423 4. 31 4. 33? (a)? See the table below. For next year (x = 6), the number of transistors (in millions) is forecasted as y = 126 + 18(6) = 126 + 108 = 234. Then y = a + bx, where y = number sold, x = price, and | 4. 32? a) | x | y | xy | x2 | | | 16 | 330 | 5, 280 | 256 | | | 12 | 270 | 3, 240 | 144 | | | 18 | 380 | 6, 840 | 324 | | | 14 | 300 | 4, 200 | 196 | | | 60 | 1, 280 | 19, 560 | 920 | So at x = 2. 80, y = 1, 454. 6 – 277. 6($2. 80) = 677. 32. Now round to the nearest integer: Answer: 677 lattes. [pic] (b)? If the forecast is for 20 guests, the bar sales forecast is 50 + 18(20) = $410. Each guest accounts for an additional $18 in bar sales. | Table for Problem 4. 33 | | | | | | Year | Transistors | | | | | | | |(x) |(y) | xy | x2 | 126 + 18x | Error | Error2 ||% Error| | | |? 1 | 140 |? 140 |? 1 | 144 |–4 |? 16 | 100 (4/140)? = 2. 86% | | |? 2 | 160 |? 320 |? 4 | 162 |–2 |?? 4 | 100 (2/160)? = 1. 25% | | |? 3 | 190 |? 570 |? 9 | 180 | 10 | 100 | 100 (10/190) = 5. 26% | | |? 4 | 200 |? 800 | 16 | 198 |? 2 |?? 4 | 100 (2/200) = 1. 00% | | |? | 210 | 1, 050 | 25 | 216 |–6 |? 36 | 100 (6/210)? = 2. 86% | | Totals | 15 | | | 900 | | | 2, 800 | | (b)? MSE = 160/5 = 32 (c)? MAPE = 13. 23%/5 = 2. 65% 4. 34? Y = 7. 5 + 3. 5X1 + 4. 5X2 + 2. 5X3 (a)? 28 (b)? 43 (c)? 58 4. 35? (a)? [pic] = 13, 473 + 37. 65(1860) = 83, 502 (b)? The predicted selling price is $83, 502, but this is the average price for a house of this size. There are other factors besides square footage that will impact the selling price of a house. If such a house sold for $95, 000, then these other factors could be contributing to the additional value. (c)?

Some other quantitative variables would be age of the house, number of bedrooms, size of the lot, and size of the garage, etc. (d)? Coefficient of determination = (0. 63)2 = 0. 397. This means that only about 39. 7% of the variability in the sales price of a house is explained by this regression model that only includes square footage as the explanatory variable. 4. 36? (a)? Given: Y = 90 + 48. 5X1 + 0. 4X2 where: [pic] If: Number of days on the road (X1 = 5 and distance traveled (X2 = 300 then: Y = 90 + 48. 5 (5 + 0. 4 (300 = 90 + 242. 5 + 120 = 452. 5 Therefore, the expected cost of the trip is $452. 50. (b)? The reimbursement request is much higher than predicted by the model. This request should probably be questioned by the accountant. (c)?

A number of other variables should be included, such as: 1.? the type of travel (air or car) 2.? conference fees, if any 3.? costs of entertaining customers 4.? other transportation costs—cab, limousine, special tolls, or parking In addition, the correlation coefficient of 0. 68 is not exceptionally high. It indicates that the model explains approximately 46% of the overall variation in trip cost. This correlation coefficient would suggest that the model is not a particularly good one. 4. 37? (a, b) | Period | Demand | Forecast | Error | Running sum || error| | | 1 | 20 | 20 | 0. 00 | 0. 00 | 0. 00 | | 2 | 21 | 20 | 1. 00 | 1. 0 | 1. 00 | | 3 | 28 | 20. 5 | 7. 50 | 8. 50 | 7. 50 | | 4 | 37 | 24. 25 | 12. 75 | 21. 25 | 12. 75 | | 5 | 25 | 30. 63 |–5. 63 | 15. 63 | 5. 63 | | 6 | 29 | 27. 81 | 1. 19 | 16. 82 | 1. 19 | | 7 | 36 | 28. 41 | 7. 59 | 24. 41 | 7. 59 | | 8 | 22 | 32. 20 |–10. 20 | 14. 21 | 10. 20 | | 9 | 25 | 27. 11 |–2. 10 | 12. 10 | 2. 10 | | 10 | 28 | 26. 05 |?? 1. 95 | 14. 05 |?? | | | | | | 1. 95 | | | | | | | | | | | | | | | | | MAD[pic]5. 00 | Cumulative error = 14. 05; MAD = 5? Tracking = 14. 05/5

(2. 82 4. 38? (a)? least squares equation: Y = –0. 158 + 0. 1308X (b)? Y = –0. 158 + 0. 1308(22) = 2. 719 million (c)? coefficient of correlation = r = 0. 966 coefficient of determination = r2 = 0. 934 4. 39 | Year X | Patients Y | X2 | Y2 | XY | |? 1 |? 36 |?? 1 |? 1, 296 |?? 36 | |? 2 |? 33 |?? |? 1, 089 |?? 66 | |? 3 |? 40 |?? 9 |? 1, 600 |? 120 | |? 4 |? 41 |? 16 |? 1, 681 |? 164 | |? 5 |? 40 |? 25 |? 1, 600 |? 200 | |? 6 |? 55 |? 36 |? 3, 025 |? 330 | |? 7 |? 60 |? 49 |? 3, 600 |? 420 | |? 8 |? 54 |? 64 |? 2, 916 |? 432 | |? 9 |? 58 |? 81 |? 3, 364 |? 522 | | 10 |? 61 | 100 |? 3, 721 |? 10 | | 55 | | | 478 | | | X | Y | Forecast | Deviation | Deviation | |? 1 | 36 | 29. 8 + 3. 28 (? 1 = 33. 1 |? 2. 9 | 2. 9 | |? 2 | 33 | 29. 8 + 3. 28 (? 2 = 36. 3 |–3. 3 | 3. 3 | |? 3 | 40 | 29. 8 + 3. 28 (? 3 = 39. 6 |? 0. 4 | 0. 4 | |? 4 | 41 | 29. 8 + 3. 28 (? 4 = 42. 9 |–1. 9 | 1. 9 | |? 5 | 40 | 29. 8 + 3. 28 (? 5 = 46. 2 |–6. 2 | 6. 2 | |? 6 | 55 | 29. 8 + 3. 28 (? 6 = 49. 4 |? 5. 6 | 5. 6 | |? 7 | 60 | 29. 8 + 3. 28 (? 7 = 52. 7 |? 7. 3 | 7. 3 | |? | 54 | 29. 8 + 3. 28 (? 8 = 56. 1 |–2. 1 | 2. 1 | |? 9 | 58 | 29. 8 + 3. 28 (? 9 = 59. 3 |–1. 3 | 1. 3 | | 10 | 61 | 29. 8 + 3. 28 (10 = 62. 6 |–1. 6 | 1. 6 | | | | | | | (= | | | | | | 32. 6 | | | | | | MAD = 3. 26 | The MAD is 3. 26—this is approximately 7% of the average number of patients and 10% of the minimum number of patients. We also see absolute deviations, for years 5, 6, and 7 in the range 5. 6–7. 3.

The comparison of the MAD with the average and minimum number of patients and the comparatively large deviations during the middle years indicate that the forecast model is not exceptionally accurate. It is more useful for predicting general trends than the actual number of patients to be seen in a specific year. 4. 40 | | Crime | Patients | | | | | Year | Rate X | Y | X2 | Y2 | XY | |? 1 |? 58. 3 |? 36 |? 3, 398. 9 |? 1, 296 |? 2, 098. 8 | |? 2 |? 61. 1 |? 33 |? 3, 733. 2 |? 1, 089 |? 2, 016. 3 | |? 3 |? 73. |? 40 |? 5, 387. 6 |? 1, 600 |?

2, 936. 0 | |? 4 |? 75. 7 |? 41 |? 5, 730. 5 |? 1, 681 |? 3, 103. 7 | |? 5 |? 81. 1 |? 40 |? 6, 577. 2 |? 1, 600 |? 3, 244. 0 | |? 6 |? 89. 0 |? 55 |? 7, 921. 0 |? 3, 025 |? 4, 895. 0 | |? 7 | 101. 1 |? 60 | 10, 221. 2 |? 3, 600 |? 6, 066. 0 | |? 8 |? 94. 8 |? 54 |? 8, 987. 0 |? 2, 916 |? 5, 119. 2 | |? 9 | 103. 3 |? 58 | 10, 670. 9 |? 3, 364 |? 5, 991. 4 | | 10 | 116. 2 |? 61 | 13, 502. 4 |? 3, 721 |? 7, 088. 2 | | Column | | 854. | | | 478 | | Totals | | | | | | | months) |(Millions) |(1, 000, 000s) | | | | | Year |(X) |(Y) | X2 | Y2 | XY | |? 1 |? 7 | 1. 5 |? 49 |? 2. 25 | 10. 5 | |? 2 |? 2 | 1. 0 |?? 4 |? 1. 00 |? 2. 0 | |? 3 |? 6 | 1. 3 |? 36 |? 1. 69 |? 7. 8 | |? 4 |? 4 | 1. 5 |? 16 |? 2. 25 |? 6. 0 | |? 5 | 14 | 2. 5 | 196 |? 6. 25 | 35. 0 | |? 6 | 15 | 2. 7 | 225 |? 7. 9 | 40. 5 | |? 7 | 16 | 2. 4 | 256 |? 5. 76 | 38. 4 | |? 8 | 12 | 2. 0 | 144 |? 4. 00 | 24. 0 | |? 9 | 14 | 2. 7 | 196 |? 7. 29 | 37. 8 | | 10 | 20 | 4. 4 | 400 | 19. 36 | 88. 0 | | 11 | 15 | 3. 4 | 225 | 11. 56 | 51. 0 | | 12 |? 7 | 1. 7 |? 49 |? 2. 89 | 11. 9 | Given: Y = a + bX where: [pic] and (X = 132, (Y = 27. 1, (XY = 352. 9, (X2 = 1796, (Y2 = 71. 59, [pic] = 11, [pic]= 2. 26. Then: [pic] andY = 0. 511 + 0. 159X (c)?

Given a tourist population of 10, 000, 000, the model predicts a ridership of: Y = 0. 511 + 0. 159 (10 = 2. 101, or 2, 101, 000 persons. (d)? If there are no tourists at all, the model predicts a ridership of 0. 511, or 511, 000 persons. One would not place much confidence in this forecast, however, because the number of tourists (zero) is outside the range of data used to develop the model. (e)? The standard error of the estimate is given by: (f)? The correlation coefficient and the coefficient of determination are given by: [pic] 4. 42? (a)? This problem gives students a chance to tackle a realistic problem in business, i. e. , not enough data to make a good forecast.

As can be seen in the accompanying figure, the data contains both seasonal and trend factors. [pic] Averaging methods are not appropriate with trend, seasonal, or other patterns in the data. Moving averages smooth out seasonality. Exponential smoothing can forecast January next year, but not farther. Because seasonality is strong, a naive model that students create on their own might be best. (b) One model might be: Ft+1 = At–11 That is forecastnext period = actualone year earlier to account for seasonality. But this ignores the trend. One very good approach would be to calculate the increase from each month last year to each month this year, sum all 12 increases, and divide by 12.

The forecast for next year would equal the value for the same month this year plus the average increase over the 12 months of last year. (c) Using this model, the January forecast for next year becomes: [pic] where 148 = total monthly increases from last year to this year. The forecasts for each of the months of next year then become: | Jan. | 29 | | July. | 56 | | Feb. | 26 | | Aug. | 53 | | Mar. | 32 | | Sep. | 45 | | Apr. | 35 | | Oct. | 35 | | May. | 42 | | Nov. | 38 | | Jun. | 50 | | Dec. | 29 | Both history and forecast for the next year are shown in the accompanying figure: [pic] 4. 3? (a) and (b) See the following table: | | Actual | Smoothed | | Smoothed | | | Week | Value | Value | Forecast | Value | Forecast | | t | A(t) | Ft ((= 0. 2) | Error | Ft ((= 0. 6)| Error | | 1 | 50 |+50. 0 |? +0. 0 |+50. 0 |? +0. 0 | | 2 | 35 |+50. 0 |–15. 0 |+50. 0 |–15. 0 | | 3 | 25 | +47. 0 |–22. 0 |+41. 0 |–16. 0 | | 4 | 40 |+42. 6 |? –2. 6 |+31. 4 |? +8. 6 | | 5 | 45 |+42. 1 |? –2. 9 |+36. 6 |? +8. | | 6 | 35 |+42. 7 |? –7. 7 |+41. 6 |? –6. 6 | | 7 | 20 |+41. 1 |–21. 1 |+37. 6 |–17. 6 | | 8 | 30 |+36. 9 |? –6. 9 |+27. 1 |? +2. 9 | | 9 | 35 |+35. 5 |? –0. 5 |+28. 8 |? +6. 2 | | 10 | 20 |+35. 4 |–15. 4 |+32. 5

|–12. 5 | | 11 | 15 |+32. 3 |–17. 3 |+25. 0 |–10. 0 | | 12 | 40 |+28. 9 |+11. 1 | +19. 0 |+21. 0 | | 13 | 55 |+31. 1 |+23. 9 |+31. 6 |+23. 4 | | 14 | 35 |+35. 9 |? 0. 9 |+45. 6 |–10. 6 | | 15 | 25 |+36. 7 |–10. 7 |+39. 3 |–14. 3 | | 16 | 55 | +33. 6 |+21. 4 |+30. 7 |+24. 3 | | 17 | 55 |+37. 8 |+17. 2 |+45. 3 |? +9. 7 | | 18 | 40 |+41. 3 |? –1. 3 |+51. 1 |–11. 1 | | 19 | 35 |+41. 0 |? –6. 0 |+44. 4 |? –9. 4 | | 20 | 60 |+39. 8 |+20. 2 |+38. 8 |+21. 2 | | 21 | 75 |+43. 9 |+31. 1 | +51. 5 |+23. 5 | | 22 | 50 |+50. 1 |? –0. 1 |+65. 6 |–15. | | 23 | 40 |+50. 1 |–10. 1 |+56. 2 |–16. 2 | | 24 | 65 |+48. 1 |+16. 9 |+46. 5 |+18. 5 | | 25 | |+51. 4 | |+57. 6 | | | | | MAD = 11. 8 | MAD = 13. 45 | (c)? Students should note how stable the smoothed values are for (= 0. 2. When compared to actual week 25 calls of 85, the smoothing constant, (= 0. 6, appears to do a slightly better job. On the basis of the standard error of the estimate and the MAD, the 0. 2 constant is better. However, other smoothing constants need to be examined. | 4. 4 | | | | | | | Week | Actual Value | Smoothed Value | Trend Estimate | Forecast | Forecast | | t | At | Ft ((= 0. 3) | Tt ((= 0. 2) | FITt | Error | |? 1 | 50. 000 | 50. 000 |? 0. 000 | 50. 000 |?? 0. 000 | |? 2 | 35. 000 | 50. 000 |? 0. 000 | 50. 000 |–15. 000 | |? 3 | 25. 000 | 45. 500 |–0. 900 | 44. 600 |–19. 600 | |? 4 | 40. 000 | 38. 720 |–2. 076 | 36. 644 |?? 3. 56 | |? 5 | 45. 000 | 37. 651 |–1. 875 | 35. 776 |?? 9. 224 | |? 6 | 35. 000 | 38. 543 |–1. 321 | 37. 222 |? –2. 222 | |? 7 | 20. 000 | 36. 555 |–1. 455 | 35. 101 |–15. 101 | |? 8 | 30. 000 | 30. 571 |–2. 361 | 28. 210 |?? 1. 790 | |? 9 | 35. 000 | 28. 747 |–2. 253 | 26. 494 |?? 8. 506 | | 10 | 20. 000 | 29. 046 |–1. 743 | 27. 03 |? –7. 303 | | 11 | 15. 000 | 25. 112 |–2. 181 | 22. 931 |? –7. 931 | | 12 | 40. 000 | 20. 552 |–2. 657 | 17. 895 |? 22. 105 | | 13 | 55. 000 | 24. 526 |–1. 331 | 23. 196 |? 31. 804 | | 14 | 35. 000 | 32. 737 |? 0. 578 | 33. 315 |?? 1. 685 | | 15 | 25. 000 | 33. 820 |? 0. 679 | 34. 499 |? –9. 499 | | 16 | 55. 000 | 31. 649 |? 0. 109 | 31.

58 |? 23. 242 | | 17 | 55. 000 | 38. 731 |? 1. 503 | 40. 234 |? 14. 766 | | 18 | 40. 000 | 44. 664 |? 2. 389 | 47. 053 |? –7. 053 | | 19 | 35. 000 | 44. 937 |? 1. 966 | 46. 903 |–11. 903 | | 20 | 60. 000 | 43. 332 |? 1. 252 | 44. 584 |? 15. 416 | | 21 | 75. 000 | 49. 209 |? 2. 177 | 51. 386 |? 23. 614 | | 22 | 50. 000 | 58. 470 |? 3. 94 | 62. 064 |–12. 064 | | 23 | 40. 000 | 58. 445 |? 2. 870 | 61. 315 |–21. 315 | | 24 | 65. 000 | 54. 920 |? 1. 591 | 56. 511 |?? 8. 489 | | 25 | | 59. 058 |? 2. 100 | 61. 158 | | To evaluate the trend adjusted exponential smoothing model, actual week 25 calls are compared to the forecasted value. The model appears to be producing a forecast approximately mid-range between that given by simple exponential smoothing using (= 0. 2 and (= 0. 6.

Trend adjustment does not appear to give any significant improvement. 4. 45 | Month | At | Ft || At – Ft | |(At – Ft) | | May | 100 | 100 | 0 | 0 | | June | 80 | 104 | 24 |–24 | | July | 110 | 99 | 11 | 11 | | August | 115 | 101 | 14 | 14 | | September | 105 | 104 | 1 | 1 | | October | 110 | 104 | 6 | 6 | | November | 125 | 105 | 20 | 20 | December | 120 | 109 | 11 | 11 | | | | | Sum: 87 | Sum: 39 | | 4. 46 (a) | | X | Y | X2 | Y2 | XY | | |? 421 |? 2. 90 |? 177241 |?? 8. 41 |? 1220. 9 | | |? 377 |? 2. 93 |? 142129 |?? 8. 58 |? 1104. 6 | | |? 585 |? 3. 00 |? 342225 |?? 9. 00 |? 1755. 0 | | |? 690 |? 3. 45 |? 476100 |? 11. 90 |? 2380. 5 | | |? 608 |? 3. 66 |? 369664 |? 13. 40 |? 2225. 3 | | |? 390 |? 2. 88 |? 52100 |?? 8. 29 |? 1123. 2 | | |? 415 |? 2. 15 |? 172225 |?? 4. 62 |?? 892. 3 | | |? 481 |? 2. 53 |? 231361 |?? 6. 40 |? 1216. 9 | | |? 729 |? 3. 22 |? 531441 |? 10. 37 |? 2347. 4 | | |? 501 |? 1. 99 |? 251001 |?? 3. 96 |?? 997. 0 | | |? 613 |? 2. 75 |? 375769 |?? 7. 56 |? 1685. 8 | | |? 709 |? 3. 90 |? 502681 |? 15. 21 |? 2765. 1 | | |? 366 |? 1. 60 |? 133956 |?? 2. 56 |?? 585. 6 | | | Column | 6885 | | 36. 6 | | | | totals | |

| | | | January | 400 |— |— | — |— | | February | 380 | 400 |— | 20. 0 |— | | March | 410 | 398 |— | 12. 0 |— | | April | 375 | 399. 2 | 396. 67 | 24. 2 | 21. 67 | | May | 405 | 396. 8 | 388. 33 | 8. 22 | 16. 67 | | | | | MAD = | | 16. 11| | | 19. 17| | (d)Note that Amit has more forecast observations, while Barbara's moving average does not start until month 4. Also note that the MAD for Amit is an average of 4 numbers, while Barbara's is only 2. Amit's MAD for exponential smoothing (16. 1) is lower than that of Barbara's moving average (19. 17). So his forecast seems to be better. 4. 48? (a) | Quarter | Contracts X | Sales Y | X2 | Y2 | XY | | 1 |? 153 |? 8 |? 23, 409 |? 64 |? 1, 224 | | 2 |? 172 | 10 |? 29, 584 | 100 |? 1, 720 | | 3 |? 197 | 15 |? 38, 809 | 225 |? 2, 955 | | 4 |? 178 |? 9 |? 31, 684 |? 81 |? 1, 602 | | 5 |? 185 | 12 |? 34, 225 | 144 |? 2, 220 | | 6 |? 199 | 13 |? 39, 601 | 169 |? 2, 587 | | 7 |? 205 | 12 |? 42, 025 | 144 |? , 460 | | 8 |? 226 | 16 |? 51, 076 | 256 |? 3, 616 | | Totals | | 1, 515 | | | 95 | b = (18384 – 8 (189. 375 (11. 875)/(290, 413 – 8 (189. 375 (189. 375) = 0. 1121 a = 11. 875 – 0. 1121 (189. 375 = –9. 3495 Sales (y) = –9. 349 + 0. 1121 (Contracts) (b) [pic] 4. 49? (a) | Method (Exponential Smoothing | | | | 0. 6 = (| | | | Year | Deposits (Y) | Forecast || Error| | Error2 | | 1 |? 0. 25 | 0. 25 | 0. 00 |? 0. 00 | | 2 |? . 24 | 0. 25 | 0. 01 |? 0. 0001 | | 3 |? 0. 24 | 0. 244 | 0. 004 |? 0. 0000 | | 4 |? 0. 26 | 0. 241 | 0. 018 |? 0. 0003 | | 5 |? 0. 25 | 0. 252 | 0. 002 |? 0. 00 | | 6 |? 0. 30 | 0. 251 | 0. 048 |? 0. 0023 | | 7 |? 0. 31 | 0. 280 | 0. 029 |? 0. 0008 | | 8 |? 0. 32 | 0. 298 | 0. 021 |? 0. 0004 | | 9 |? 0. 24 | 0. 311 | 0. 071 |? 0. 0051 | | 10 |? 0. 26 | 0. 68 | 0. 008 |? 0. 0000 | | 11 |? 0. 25 | 0. 263 | 0. 013 |? 0. 0002 | | 12 |? 0. 33 | 0. 255 | 0. 074 |? 0. 0055 | | 13 |? 0. 50 | 0. 300 | 0. 199 |? 0. 0399 | | 14 |? 0. 95 | 0. 420 | 0. 529 |? 0. 2808 | | 15 |? 1. 70 | 0. 738 | 0. 961 |? 0. 925 | | 16 |? 2. 30 | 1. 315 | 0. 984 |? 0. 9698 | | 17 |? 2. 80 | 1. 906 | 0. 893 |? 0. 7990 | | 18 |? 2. 80 | 2. 442 | 0. 357 |? 0. 278

| | 19 |? 2. 70 | 2. 656 | 0. 043 |? 0. 0018 | | 20 |? 3. 90 | 2. 682 | 1. 217 |? 1. 4816 | | 21 |? 4. 90 | 3. 413 | 1. 486 |? 2. 2108 | | 22 |? 5. 30 | 4. 305 | 0. 994 |? 0. 9895 | | 23 |? 6. 20 | 4. 90 | 1. 297 |? 1. 6845 | | 24 |? 4. 10 | 5. 680 | 1. 580 |? 2. 499 | | 25 |? 4. 50 | 4. 732 | 0. 232 |? 0. 0540 | | 26 |? 6. 10 | 4. 592 | 1. 507 |? 2. 2712 | | 27 |? 7. 0 | 5. 497 | 2. 202 |? 4. 8524 | | 28 | 10. 10 | 6. 818 | 3. 281 | 10. 7658 | | 29 | 15. 20 | 8. 787 | 6. 412 | 41. 1195 | (Continued) 4. 49? (a)? (Continued) | Method (Exponential Smoothing | | | | 0. 6 = (| | | | Year | Deposits (Y) | Forecast || Error| | Error2 | | 30 |? 18. 10 | 12. 6350 |?? 5. 46498 | 29. 8660 | | 31 |? 24. 10 | 15. 9140 | 8. 19 | 67. 01 | | 32 |? 25. 0 | 20. 8256 | 4. 774 | 22. 7949 | | 33 |? 30. 30 | 23. 69 |?? 6. 60976 | 43. 69 | | 34 |? 36. 00 | 27. 6561 |?? 8. 34390 | 69. 62 | | 35 |? 31. 10 | 32. 6624 |?? 1. 56244 |???? 2. 44121 | | 36 |? 31. 70 | 31. 72 |??? 0. 024975 |??? 0. 000624 | | 37 |? 38. 50 | 31. 71 | 6. 79 |? 46. 1042 | | 38 |? 47. 90 | 35. 784 | 12. 116 | 146. 798 | | 39 |? 49. 10 | 43. 0536 | 6. 046 | 36. 56 | | 40 |? 55. 80 | 46. 814 |?? 9. 11856 |?? 83. 1481 | | 41 |? 70. 10 | 52. 1526 | 17. 9474 | 322. 11 | | 42 |? 70. 90 | 62. 9210 |?? 7. 97897 | 63. 66 | | 43 |? 79. 10 | 67. 7084 | 11. 3916 | 129. 768 | | 44 |? 94. 00 | 74. 5434 | 19. 4566 | 378. 561 | | TOTALS | | 787. 30 | | | | 150. 3 | | | 1, 513. 22 | | AVERAGE |??? 17. 8932 | |?? 3. 416 |?? 34. 39 | | | | |(MAD) |(MSE) | | Next period forecast = 86. 2173 | Standard error = 6. 07519 | Method (Linear Regression (Trend Analysis) | | Year | Period (X) | Deposits (Y) | Forecast | Error2 | |? 1 |? 1 | 0. 25 |–17. 330 | 309. 061 | |? 2 |? 2 | 0. 24 |–15. 692 | 253. 823 | |? 3 |? 3 | 0. 24 |–14. 054 | 204. 31 | |? 4 |? 4 | 0. 26 |–12. 415 | 160. 662 | |? 5 |? 5 | 0. 25 |–10. 777 | 121. 594 | |? 6 |? 6 | 0. 30 |? –9. 1387 | 89. 0883 | |? 7 |? 7 | 0. 31 |? –7. 50 | 61. 0019 | |? 8 |? 8 | 0. 32 |? –5. 8621 | 38. 2181 | |? |? 9 | 0. 24 |? –4. 2238 | 19. 9254 | | 10 | 10 | 0. 26 |? –2. 5855 | 8. 09681 | | 11 | 11 | 0. 25 |? –0. 947 |

1. 43328 | | 12 | 12 | 0. 33 |? 0. 691098 | 0. 130392 | | 13 | 13 | 0. 50 |? 2. 329 | 3. 34667 | | 14 | 14 | 0. 95 |? 3. 96769 | 9. 10642 | | 15 | 15 | 1. 70 |? 5. 60598 | 15. 2567 | | 16 | 16 | 2. 30 |? 7. 24427 | 24. 4458 | | 17 | 17 | 2. 0 |? 8. 88257 | 36. 9976 | | 18 | 18 | 2. 80 |? 10. 52 | 59. 6117 | | 19 | 19 | 2. 70 |? 12. 1592 | 89. 4756 | | 20 | 20 | 3. 90 |? 13. 7974 | 97. 9594 | | 21 | 21 | 4. 90 |? 15. 4357 | 111. 0 | | 22 | 22 | 5. 30 |? 17. 0740 | 138. 628 | | 23 | 23 | 6. 20 |? 18. 7123 | 156. 558 | | 24 | 24 | 4. 10 |? 20. 35 | 264. 083 | | 25 | 25 | 4. 50 |? 21. 99 | 305. 62 | | 26 | 26 | 6. 10 |? 23. 6272 | 307. 203 | | 27 | 27 | 7. 70 |? 25. 2655 | 308. 547 | | 28 | 28 | 10. 10 |? 26. 9038 | 282. 367 | | 29 | 29 | 15. 20 |? 28. 5421 | 178. 011 | | 30 | 30 | 18. 10 |? 30. 18 | 145. 936 | | 31 | 31 | 24. 10 |? 31. 8187 | 59. 58 | | 32 | 32 | 25. 60 |? 33. 46 | 61. 73 | | 33 | 33 | 30. 30 |? 35. 0953 | 22. 9945 | | 34 | 34 | 36. 0 |? 36. 7336 | 0. 5381 | | 35 | 35 | 31. 10 |? 38. 3718 | 52. 8798 | | 36 | 36 | 31. 70 |? 40. 01 | 69. 0585 | | 37 | 37 | 38. 50 |? 41. 6484 | 9. 91266 | | 38 | 38 | 47. 90 |? 43. 2867 | 21. 2823 | | 39 | 39 | 49. 10 |? 44. 9250 | 17. 43 | | 40 | 40 | 55. 80 |? 46. 5633 |? ? 85. 3163 | | 41 | 41 | 70. 10 |? 48. 2016 |? 479. 54 | | 42 | 42 | 70. 90 |? 49. 84 |? 443. 28 | | 43 | 43 | 79. 10 |? 51. 4782 |? 762. 964 | | 44 | 44 | 94. 00 |? 53. 1165 | 1, 671. 46 | | TOTALS | | 990. 00 | | | 787. 30 | | | | | | | | | | | | | 7, 559. 95 | | | AVERAGE | 22. 50 | 17. 893 | | 171. 817 | | | | | |(MSE) | | Method (Least squares–Simple Regression on GSP | | | a | b | | | | |–17. 636 | 13. 936 | | | | | Coefficients: | GSP | Deposits | | | | | Year |(X) |(Y) | Forecast || Error| | Error2 | |? 1 | 0. 40 |? 0. 25 |–12. 198 |? 12. 4482 |? 154. 957 | |? 2 | 0. 40 |? 0. 24 |–12. 198 |? 12. 4382 |? 154. 71 | |? 3 | 0. 50 |? 0. 24 |–10. 839 |? 11. 0788 |? 122. 740 | |? 4 | 0. 70 |? 0. 26 |–8. 12 |?? 8. 38 |?? 70. 226 | |? 5 | 0. 90 |? 0. 25 |–5. 4014 |?? 5. 65137 |?? 31. 94 | |? 6 | 1. 00 |? 0. 30 |–4. 0420 |?? 4. 342 |?? 18. 8530 | |? 7 | 1. 40 |? 0. 31 |? 1. 39545 |?? 1. 08545 |??? 1.

17820 | |? 8 | 1. 70 |? 0. 32 |? 5. 47354 |?? 5. 5354 |?? 26. 56 | |? 9 | 1. 30 |? 0. 24 |? 0. 036086 |?? 0. 203914 |??? 0. 041581 | | 10 | 1. 20 |? 0. 26 |–1. 3233 |?? 1. 58328 |??? 2. 50676 | | 11 | 1. 10 |? 0. 25 |–2. 6826 |?? 2. 93264 |??? 8. 60038 | | 12 | 0. 90 |? 0. 33 |–5. 4014 |?? 5. 73137 |?? 32. 8486 | | 13 | 1. 20 |? 0. 50 |–1. 3233 |?? 1. 82328 |??? 3. 32434 | | 14 | 1. 20 |? 0. 95 |–1. 3233 |?? 2. 27328 |??? 5. 16779 | | 15 | 1. 20 |? 1. 70 |–1. 3233 |?? 3. 02328 |??? 9. 14020 | | 16 | 1. 60 |? 2. 30 |? 4. 11418 |?? 1. 81418 |??? 3. 9124 | | 17 | 1. 50 |? 2. 80 |? 2. 75481 |?? 0. 045186 |??? 0. 002042 | | 18 | 1. 60 |? 2. 80 |? 4. 11418 |?? 1. 31418 |??? 1. 727 | | 19 | 1. 70 |? 2. 70 |? 5. 47354 |?? 2. 77354 |??? 7. 69253 | | 20 | 1. 90 |? 3. 90 |? 8. 19227 |?? 4. 29227 |?? 18. 4236 | | 21 | 1. 90 |? 4. 90 |? 8. 19227 |?? 3. 29227 |?? 10. 8390 | | 22 | 2. 30 |? 5. 30 | 13. 6297 |?? 8. 32972 |?? 69. 3843 | | 23 | 2. 50 |? 6. 20 | 16. 3484 |? 10. 1484 |? 102. 991 | | 24 | 2. 80 |? 4. 10 | 20. 4265 |? 16. 3265 |? 266. 56 | | 25 | 2. 90 |? 4. 50 | 21. 79 |? 17. 29 |? 298. 80 | | 26 | 3. 40 |? 6. 10 | 28. 5827 |? 22. 4827 |? 505. 473 | | 27 | 3. 80 |? 7. 70 | 34. 02 |? 26. 32 |? 692. 752 | | 28 | 4. 10 | 10. 10 | 38. 0983 |? 27. 9983 |? 783. 90 | | 29 | 4. 00 | 15. 20 | 36. 74 |? 21. 54 |? 463. 924 | | 30 | 4. 00 | 18. 10 | 36. 74 |? 18. 64 |? 347. 41 | | 31 | 3. 90 | 24. 10 | 35. 3795 |? 11. 2795 |? 127. 228 | | 32 | 3. 80 | 25. 60 | 34. 02 |?? 8. 42018 |?? 70. 8994 | | 33 | 3. 0 | 30. 30 | 34. 02 |?? 3. 72018 |?? 13. 8397 | | 34 | 3. 70 | 36. 00 | 32. 66 |?? 3. 33918 |?? 11. 15 | | 35 | 4. 10 | 31. 10 | 38. 0983 |?? 6. 99827 |?? 48. 9757 | | 36 | 4. 10 | 31. 70 | 38. 0983 |?? 6. 39827 |? 40. 9378 | | 37 | 4. 00 | 38. 50 | 36. 74 |?? 1. 76 |??? 3. 10146 | | 38 | 4. 50 | 47. 90 | 43. 5357 |?? 4. 36428 |?? 19. 05 | | 39 | 4. 60 | 49. 10 | 44. 8951 |?? 4. 20491 |?? 17. 6813 | | 40 | 4. 50 | 55. 80 | 43. 5357 |? 12. 2643 |? 150. 412 | | 41 | 4. 60 | 70. 10 | 44. 951 |? 25. 20 |? 635. 288 | | 42 | 4. 60 | 70. 90 | 44. 8951 |? 26. 00 |? 676. 256 | | 43 | 4. 70 | 79. 10 | 46.

2544 |? 32. 8456 | 1, 078. 83 | | 44 | 5. 00 | 94. 00 | 50. 3325 |? 43. 6675 | 1, 906. 85 | | TOTALS | | | | 451. 223 | 9, 016. 45 | | AVERAGE | | | |? 10. 2551 |? 204. 92 | | | | | |? (MAD) |? (MSE) | Given that one wishes to develop a five-year forecast, trend analysis is the appropriate choice. Measures of error and goodness-of-fit are really irrelevant.

Exponential smoothing provides a forecast only of deposits for the next year —and thus does not address the five-year forecast problem. In order to use the regression model based upon GSP, one must first develop a model to forecast GSP, and then use the forecast of GSP in the model to forecast deposits. This requires the development of two models—one of which (the model for GSP) must be based solely on time as the independent variable (time is the only other variable we are given). (b)? One could make a case for exclusion of the older data. Were we to exclude data from roughly the first 25 years, the forecasts for the later year