Chapter 6

FORECASTING

QUESTIONS AND ANSWERS

Q6.1 What is the delphi method? Describe its main advantages and limitations.

Q6.1 ANSWER

In the Delphi method, experts are individually posed questions relating to an underlying forecasting problem. Then, an independent party seeks to form a consensus forecast by providing feedback to the various experts in a manner that prevents identification of individual positions. The method can be useful in providing consensus forecasts that are unaffected by the persuasive ability of individual expert participants. Needless to say, the effectiveness of this method is sensitive to the expertise of the independent party chosen.

Q6.2 Describe the main advantages and limitations of survey data.

Q6.2 ANSWER

Survey data can be highly useful in short-term forecasting when carefully used to elicit consumer perceptions and attitudes. However, survey data are “soft” when they don’t relate to actual market transactions and can be unreliable when consumers have incentives to misreport information.

Q6.3 What is trend projection, and why is this method often employed in economic forecasting?

Q6.3 ANSWER

Trend projection involves a simple extrapolation of historical patterns of economic activity. A primary advantage is that many economic series involve a substantial trend element due to the effects of population and economic growth and can be readily forecast using trend projection methods. For example, when past use, personal selling or advertising creates a high degree of customer loyalty, a strong trend element in product sales data will emerge. Similarly, when repeat business is high, there is a large trend element in firm sales data. As a result, trend projection methods are often employed to forecast the long-term secular increase or decrease in economic data.
Q6.4 What is the basic shortcoming of trend projection that barometric approaches improve on?

A basic shortcoming of trend projection is that the method is incapable of forecasting the magnitude or duration of divergences from trend and is not helpful for indicating fundamental changes in trend (i.e., turning points). Therefore, simple trend projection methods are incapable of forecasting the magnitude of cyclical fluctuations, seasonal variation, and irregular or random influences. To forecast the magnitude of such deviations from trend, managers often employ the barometric approach to forecasting.

Q6.5 What advantage do diffusion and composite indexes provide in the barometric approach to forecasting?

Unlike trend projection methods, barometric approaches seek to incorporate the effects of changing economic conditions in forecast values. Through the use of leading, coincident, and lagging indicators, barometric approaches can provide insight regarding both the direction and magnitude of cyclical turning points and fluctuations from trend.

Q6.6 Explain how the econometric model approach to forecasting could be used to examine various “what if” questions about the future.

Econometric models are a highly useful forecasting technique for answering a wide variety of “what if” questions regarding the future. This stems from the fact that econometric models reflect the causal relation between Y (the forecast value) and a series of independent X variables. When a range of X values relating to various pessimistic to optimistic scenarios concerning future events is incorporated into a given econometric model, the resulting effects on Y become readily apparent. Thus, quantifiable answers to various “what if” questions can be obtained.

Q6.7 Describe the data requirements that must be met if regression analysis is to provide a useful basis for forecasting.

If regression analysis is to provide a useful basis for forecasting, a number of important conditions must be met. First, a sufficient number of sample observations must be available for analysis. For small populations, as few as 30 or 40 observations may be
sufficient. Larger samples are needed for larger populations and when particularly difficult forecasting problems are encountered. Second, all relevant variables must be properly incorporated in the analysis. This involves data measurement and model specification issues that must be addressed. And third, there must be a high degree of stability over time between the dependent and independent variables under consideration.

Q6.8 Would a linear regression model of the advertising/sales relation be appropriate for forecasting the advertising levels at which threshold or saturation effects become prevalent?

Q6.8 ANSWER

No, a linear model of the advertising-sales relation is not appropriate for estimating the advertising levels where “threshold” or “saturation” effects become prevalent. A nonlinear method of estimation is appropriate when advertising by a firm or an industry is subject to such influences. Quadratic, log-linear, or logistic models are often employed for this purpose.

Q6.9 Cite some examples of forecasting problems that might be addressed using regression analysis of complex multiple-equation systems of economic relations.

Q6.9 ANSWER

Econometric analysis of multiple-equation systems of economic relations is a forecasting technique that is useful for reflecting the effects of important economic changes on related sectors, industries, or firms. It is most useful when indirect linkages between sectors are few in number and can be estimated with a great deal of precision. At the national level, for example, this type of econometric analysis has been used extensively to analyze changes in GDP, interest rates, energy, and water requirements. Similarly, firms might use a system method of analysis to measure the effects of changing energy, labor, or capital costs on demand conditions for related products.

Q6.10 What are the main characteristics of accurate forecasts?

Q6.10 ANSWER

The main characteristics of accurate forecasts are a close correspondence, on average, between actual and forecast values and a high correlation between the actual and forecast series. When these two criteria are met, actual and forecast data will be closely related, and a desirable low level of average forecast error (root mean squared forecast error) will be apparent.
SELF-TEST PROBLEMS AND SOLUTIONS

ST6.1 Gross Domestic Product (GDP) is a measure of overall activity in the economy. It is defined as the value at the final point of sale of all goods and services produced during a given period by both domestic and foreign-owned enterprises. GDP data for the 1966-2000 period offer the basis to test the abilities of simple constant change and constant growth models to describe the trend in GDP over time. However, regression results generated over the entire 1966-2000 period cannot be used to forecast GDP over any subpart of that period. To do so would be to overstate the forecast capability of the regression model because, by definition, the regression line minimizes the sum of squared deviations over the estimation period. To test forecast reliability, it is necessary to test the predictive capability of a given regression model over data that was not used to generate that very model. In the absence of GDP data for future periods, say 2002-20007, the reliability of alternative forecast techniques can be illustrated by arbitrarily dividing historical GDP data into two subsamples: a 1966-95 30-year test period, and a 1996-2000 5-year forecast period. Regression models estimated over the 1966-95 test period can be used to “forecast” actual GDP over the 1996-2000 period. In other words, estimation results over the 1966-95 subperiod provide a forecast model that can be used to evaluate the predictive reliability of the constant growth model over the 1996-2000 forecast period.

The accompanying table shows GDP figures for the U.S. economy for the 35-year period from 1966-2000.

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<td>Time Period</td>
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<tr>
<td>2000</td>
<td>9,963.1</td>
<td>9.2066</td>
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</table>


A. Use the regression model approach to estimate the simple linear relation between the natural logarithm of GDP and time (T) over the 1966-99 subperiod, where

\[ \ln GDP_t = b_0 + b_1 T_t + u_t \]

and \( \ln GDP_t \) is the natural logarithm of GDP in year t, and T is a time trend variable (where \( T_{1966} = 1, T_{1967} = 2, T_{1968} = 3, \ldots, \text{and } T_{1995} = 30 \)); and \( u_t \) is a residual term. This is called a constant growth model because it is based on the assumption of a constant percentage growth in economic activity per year. How well does the constant growth model fit actual GDP data over this period?

B. Create a spreadsheet that shows constant growth model GDP forecasts over the 1996-2000 period alongside actual figures. Then, subtract forecast values from actual figures to obtain annual estimates of forecast error, and squared forecast error, for each year over the 1996-2000 period.

Finally, compute the correlation coefficient between actual and forecast values over the 1996-2000 period. Also compute the sample average (or root mean squared) forecast error. Based upon these findings, how well does the constant growth model generated over the 1966-95 period forecast actual GDP data over the 1996-2000 period?

ST6.1 SOLUTION

A. The constant growth model estimated using the simple regression model technique illustrates the linear relation between the natural logarithm of GDP and time. A
constant growth regression model estimated over the 1966-95 30-year period (t-statistic in parentheses), used to forecast GDP over the 1996-2000 5-year period, is:

\[
\ln GDP_t = 6.609 + 0.082T_t, \quad R^2 = 98.9\%
\]

\[
(227.74) \quad (50.19)
\]

The \( R^2 = 99.50\% \) and a highly significant \( t \) statistic for the time trend variable indicate that the constant growth model closely describes the change in GDP over the 1966-95 time frame. Nevertheless, even modest differences in the intercept term and slope coefficient over time can lead to large forecast errors.

**B.** Each constant growth GDP forecast is derived using the constant growth model coefficients estimated in part A, along with values for each respective time trend variable over the 1995-2000 period. Again, remember that \( T_{1996} = 31, T_{1997} = 32, \ldots, \) and \( T_{2000} = 35 \) and that the constant growth model provides predicted, or forecast, values for \( \ln GDP_t \). To obtain forecast values for GDP, simply take the exponent (antilog) of each predicted \( \ln GDP_t \) variable.

The following spreadsheet shows actual and constant growth model GDP forecasts for the 1996-2000 forecast period:

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP</th>
<th>ln GDP</th>
<th>Forecast ln GDP</th>
<th>Forecast GDP</th>
<th>Forecast Error (GDP - Forecast GDP)</th>
<th>Squared Forecast Error (GDP - Forecast GDP)²</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>$7,813.2</td>
<td>8.9636</td>
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<tr>
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<td>$11,200.3</td>
<td>$-2,363.5</td>
<td>$5,888,477.2</td>
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</table>

Correlation 99.92%  
Mean squared error $2,426.62

The correlation coefficient between actual and constant growth model forecast GDP is \( r_{\text{GDP,FGDP}} = 99.92\% \). The sample root mean squared forecast error is $2,426.6 billion (\( = \sqrt{5,888,477.2} \)), or 27.5% of average actual GDP over the 1996-2000 period. Thus, despite the fact that the correlation between actual and constant growth forecast model values is relatively high, forecast error is also very high. Unusually modest economic growth during the early 1990s has led to large forecast errors when data from more rapidly growing periods, like the 1980s, are used to forecast economic growth.
ST6.2 Multiple Regression. Branded Products, Inc., based in Oakland, California, is a leading producer and marketer of household laundry detergent and bleach products. About a year ago, Branded Products rolled out its new Super Detergent in 30 regional markets following its success in test markets. This isn’t just a “me too” product in a commodity market. Branded Products’ detergent contains Branded 2 bleach, a successful laundry product in its own right. At the time of the introduction, management wondered whether the company could successfully crack this market dominated by Procter & Gamble and other big players.

The following spreadsheet shows weekly demand data and regression model estimation results for Super Detergent in these 30 regional markets:
### Branded Products Demand Forecasting Problem

<table>
<thead>
<tr>
<th>Regional Market</th>
<th>Demand in Cases, Q</th>
<th>Price per Case, P</th>
<th>Competitor Price, Px</th>
<th>Advertising, Ad</th>
<th>Household Income, I</th>
<th>Estimated Demand, Q</th>
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<td><strong>55,839</strong></td>
<td><strong>1,478</strong></td>
</tr>
</tbody>
</table>

### Regression Statistics

- **Multiple R**: 0.950792455
- **R Square**: 0.904006293
- **Adjusted R Square**: 0.8886473
- **Standard R Square**: 34.97209425
- **Observations**: 30
A. Interpret the coefficient estimate for each respective independent variable.

B. Characterize the overall explanatory power of this multiple regression model in light of $R^2$ and the following plot of actual and estimated demand per week.

### Coefficients Table

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>807.9377865</td>
<td>137.8360278</td>
<td>5.861586274</td>
<td>4.09301E-06</td>
</tr>
<tr>
<td>Price, $P$</td>
<td>-5.034480186</td>
<td>0.456734361</td>
<td>-11.0229255</td>
<td>4.34134E-11</td>
</tr>
<tr>
<td>Competitor Price, $P_x$</td>
<td>4.860371507</td>
<td>1.005588065</td>
<td>4.833362367</td>
<td>5.73825E-05</td>
</tr>
<tr>
<td>Advertising, $Ad$</td>
<td>0.328043519</td>
<td>0.104441879</td>
<td>3.14091367</td>
<td>0.004293208</td>
</tr>
<tr>
<td>Household Income, $I$</td>
<td>0.008705656</td>
<td>0.001089079</td>
<td>7.993592833</td>
<td>2.38432E-08</td>
</tr>
</tbody>
</table>
C. Use the regression model estimation results to forecast weekly demand in five new markets with the following characteristics:

<table>
<thead>
<tr>
<th>Regional Forecast Market</th>
<th>Price per Case, P</th>
<th>Competitor Price, Px</th>
<th>Advertising, Ad</th>
<th>Household Income, I</th>
<th>Forecast Demand, Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>115</td>
<td>90</td>
<td>790</td>
<td>41,234</td>
<td>1,285</td>
</tr>
<tr>
<td>B</td>
<td>122</td>
<td>101</td>
<td>812</td>
<td>39,845</td>
<td>1,298</td>
</tr>
<tr>
<td>C</td>
<td>116</td>
<td>87</td>
<td>905</td>
<td>47,543</td>
<td>1,358</td>
</tr>
<tr>
<td>D</td>
<td>140</td>
<td>82</td>
<td>778</td>
<td>53,560</td>
<td>1,223</td>
</tr>
<tr>
<td>E</td>
<td>133</td>
<td>79</td>
<td>996</td>
<td>39,870</td>
<td>1,196</td>
</tr>
<tr>
<td>Average</td>
<td>125</td>
<td>88</td>
<td>856</td>
<td>44,410</td>
<td>1,272</td>
</tr>
</tbody>
</table>

ST6.2 SOLUTION

A. Coefficient estimates for the P, Px, Ad and I independent X-variables are statistically significant at the 99% confidence level. Price of the product itself (P) has the predictably negative influence on the quantity demanded, whereas the effects of competitor price (Px), advertising (Ad) and household disposable income (I) are positive as expected. The chance of finding such large t-statistics is less than 1% if, in fact, there were no relation between each variable and quantity.

B. The $R^2 = 90.4\%$ obtained by the model means that 90.4% of demand variation is explained by the underlying variation in all four independent variables. This is a relatively high level of explained variation and implies an attractive level of explanatory power. Moreover, as shown in the graph of actual and fitted (estimated) demand, the multiple regression model closely tracks week-by-week changes in demand with no worrisome divergences between actual and estimated demand over time. This means that this regression model can be used to forecast demand in similar markets under similar conditions.

C. Notice that each prospective market displays characteristics similar to those of markets used to estimate the regression model described above. Thus, the regression model estimated previously can be used to forecast demand in each regional market. Forecast results are as follows:
PROBLEMS AND SOLUTIONS

P6.1  Constant Growth Model. The U.S. Bureau of the Census publishes employment statistics and demand forecasts for various occupations.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Employment (1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill collectors</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>420</td>
</tr>
<tr>
<td>Computer engineers</td>
<td>299</td>
</tr>
<tr>
<td></td>
<td>622</td>
</tr>
<tr>
<td>Physicians assistants</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>98</td>
</tr>
<tr>
<td>Respiratory therapists</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>123</td>
</tr>
<tr>
<td>Systems analysts</td>
<td>617</td>
</tr>
<tr>
<td></td>
<td>1,194</td>
</tr>
</tbody>
</table>

A. Using a spreadsheet or hand-held calculator, calculate the ten-year growth rate forecast using the constant growth model with annual compounding, and the constant growth model with continuous compounding for each occupation.

B. Compare your answers and discuss any differences.

P6.1  SOLUTION

A. Using the assumption of annual compounding,

\[ E_t = E_0 (1 + g)^t \]

\[ 420 = 311 (1 + g)^{10} \]

\[ 1.35 = (1 + g)^{10} \]

\[ \ln(1.35) = 10 \times \ln(1 + g) \]

\[ 0.300/10 = \ln(1 + g) \]

\[ e^{0.030} = 1 + g \]

\[ 1.031 - 1 = g \]

\[ g = 0.031 \text{ or } 3.1\% \]
Using the continuous compounding assumption,

\[ E_t = E_0e^{gt} \]

\[ 420 = 311e^{10g} \]

\[ 1.35 = e^{10g} \]

\[ \ln(1.35) = 10g \]

\[ g = \frac{0.3000}{10} = 0.03 \text{ or } 3.00\% \]

Using the same methods, continuous growth model estimates for various occupations are:

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Employment (1,000)</th>
<th>Continuous Growth Model</th>
<th>Annual Compounding</th>
<th>Continuous Compounding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill collectors</td>
<td>311</td>
<td>420</td>
<td>3.05%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Computer engineers</td>
<td>299</td>
<td>622</td>
<td>7.60%</td>
<td>7.32%</td>
</tr>
<tr>
<td>Physicians assistants</td>
<td>66</td>
<td>98</td>
<td>4.03%</td>
<td>3.95%</td>
</tr>
<tr>
<td>Respiratory therapists</td>
<td>86</td>
<td>123</td>
<td>3.64%</td>
<td>3.57%</td>
</tr>
<tr>
<td>Systems analysts</td>
<td>617</td>
<td>1,194</td>
<td>6.82%</td>
<td>6.60%</td>
</tr>
</tbody>
</table>

B. For example, if the number of jobs jumps to 420,000 from 311,000 over a ten-year period, then a 3.05\% rate of job growth is indicated when annual compounding is assumed. With continuous compounding, a 3.00\% rate of growth leads to a similar growth in jobs over a ten-year period. Of course, this small difference is due to the amount of “interest-on-interest.” Either method can be employed to measure the rate of growth, but managers must make growth comparisons using a consistent basis.

P6.2 Growth Rate Estimation. According to the Recording Industry Association of America, 662.1 million CDs were shipped in 1994 by domestic manufacturers. Within five years, the number of CDs shipped rose to roughly one billion units.

A. Complete the following table showing annual CD shipments data for 1994-99 period.
B. Calculate the geometric average annual rate of growth for the 1994-99 period. (Hint: Calculate this growth rate using sales from 1994 and 1999.)

C. Calculate the arithmetic average annual rate of growth for the 1994-99 period. (Hint: This is the average of Column 4 figures.)

D. Discuss any differences in your answers to parts B and C.

P6.2 SOLUTION

A.
B. From column (3) of part A, the geometric average rate of growth is calculated as:

\[
\bar{g} = \left[ \prod_{t=1}^{n} (1 + g_t) \right]^{1/n} - 1
\]

\[
= \left[ (1.0918)(1.0775)(0.9669)(1.1247)(1.1085) \right]^{1/5} - 1
\]

\[
= 1.4181^{0.2} - 1
\]

\[
= 7.23\%
\]

Alternatively, the geometric average rate of growth is:

\[
S_t = S_0(1 + g)^t
\]

\[
938.9 = 662.1(1 + g)^5
\]

\[
1.4181 = (1 + g)^5
\]

\[
g = 7.23\%
\]

C. From column 4 of part A, the arithmetic average rate of return is calculated as:

\[
\bar{g} = \frac{1}{n} \sum_{t=1}^{n} g_t
\]

\[
= \frac{1}{5}(9.2\% + 7.7\% - 3.3\% + 12.5\% + 10.9\%)
\]

\[
= 7.4\text{ percent}
\]

D. The arithmetic average rate of return of 7.4\% is greater than the geometric (true) mean of 7.23\%. In this case, the difference is quite modest. In some instances, the difference can be huge. Note that when sales increase from $250,000 to $500,000 (a 100\% gain), but then fall back to $250,000 (a 50\% loss), the arithmetic average growth is 25\% (= (100\% - 50\%)/2) despite the fact that no net growth has occurred. As a result, when compound growth rates are considered, managers rely on the geometric average rather than the arithmetic average rate of return.

P6.3 Sales Trend Analysis. Environmental Designs, Inc., produces and installs energy-efficient window systems in commercial buildings. During the past ten years, sales revenue has increased from $25 million to $65 million.
A. Calculate the company’s growth rate in sales using the constant growth model with annual compounding.

B. Derive a five-year and a ten-year sales forecast.

P6.3 SOLUTION

A. 

\[ S_t = S_0 (1 + g)^t \]

\[ \$65,000,000 = \$25,000,000 (1 + g)^{10} \]

\[ 2.6 = (1 + g)^{10} \]

\[ \ln(2.6) = 10 \times \ln(1 + g) \]

\[ \frac{0.956}{10} = \ln(1 + g) \]

\[ e^{(0.0956)} - 1 = g \]

\[ g = 0.100 \text{ or } 10.0\% \]

B. Five-Year Sales Forecast

\[ S_t = S_0 (1 + g)^t \]

\[ = \$65,000,000 \times (1 + 0.10)^5 \]

\[ = \$65,000,000 \times 1.611 \]

\[ = \$104,715,000 \]

Ten-Year Sales Forecast

\[ S_t = S_0 (1 + g)^t \]

\[ = \$65,000,000 \times (1 + 0.10)^{10} \]

\[ = \$65,000,000 \times 2.594 \]

\[ = \$168,610,000 \]
P6.4 Cost Forecasting. Dorothy Gale, a quality-control supervisor for Wizard Products, Inc., is concerned about unit labor cost increases for the assembly of electrical snap-action switches. Costs have increased from $80 to $100 per unit over the previous three years. Gale thinks that importing switches from foreign suppliers at a cost of $115.90 per unit may soon be desirable.

A. Calculate the company’s unit labor cost growth rate using the constant rate of change model with continuous compounding.

B. Forecast when unit labor costs will equal the current cost of importing.

P6.4 SOLUTION

A. \[ C_t = C_0e^{gt} \]

\[ 100 = 80e^{3g} \]

\[ 1.25 = e^{3g} \]

\[ \ln(1.25) = 3g \]

\[ g = \frac{0.223}{3} \]

\[ = 0.074 \text{ or } 7.4\% \]

B. Import Cost \[ = C_0e^{gt} \]

\[ 115.90 = 100e^{0.074t} \]

\[ 1.159 = e^{0.074t} \]

\[ \ln(1.159) = 0.074t \]

\[ t = \frac{0.148}{0.074} \]

\[ = 2 \text{ years} \]

P6.5 Unit Sales Forecast Modeling. Boris Badenov has discovered that the change in Product A demand in any given week is inversely proportional to the change in sales of Product B in the previous week. That is, if sales of B rose by X% last week, sales of A can be expected to fall by X% this week.
A. Write the equation for next week’s sales of A, using the variables \( A = \) sales of Product A, \( B = \) sales of Product B, and \( t = \) time. Assume that there will be no shortages of either product.

B. Last week, 100 units of A and 90 units of B were sold. Two weeks ago, 75 units of B were sold. What would you predict the sales of A to be this week?

P6.5 SOLUTION

A. 
\[
A_t = A_{t-1} + \Delta A_{t-1}
\]

B. 
\[
A_t = A_{t-1} - \left( \frac{B_{t-1}}{B_{t-2}} - 1 \right) A_{t-1}.
\]

\[
= 100 - \left( \frac{90}{75} - 1 \right) 100
\]

\[
= 80.
\]

P6.6 Sales Forecast Modeling. Monica Geller must generate a sales forecast to convince the loan officer at a local bank of the viability of The Iridium, a trendy restaurant on 65th and Broadway in New York City. Geller assumes that next-period sales are a function of current income, advertising, and advertising by a competing restaurant.

A. Write an equation for predicting sales if Geller assumes that the percentage change in sales is twice as large as the percentage changes in income and advertising but that it is only one-half as large as, and of the opposite sign of, the percentage change in competitor advertising. Use the variables \( S = \) sales, \( Y = \) income, \( A = \) advertising, and \( CA = \) competitor advertising.

B. During the current period, sales total $500,000, median income per capita in the local market is $71,400, advertising is $20,000, and competitor advertising is $66,000. Previous period levels were $70,000 (income), $25,000 (advertising), and $60,000 (competitor advertising). Forecast next-period sales.
P6.6  SOLUTION

A.

\[ S_{t+1} = S_t + 2 \left( \frac{Y_t}{Y_{t-1}} - 1 \right) S_t + 2 \left( \frac{A_t}{A_{t-1}} - 1 \right) S_t - 0.5 \left( \frac{CA_t}{CA_{t-1}} - 1 \right) S_t \]

\[ = S_t + 2S_t \left( \frac{Y_t}{Y_{t-1}} \right) - 2S_t + 2S_t \left( \frac{A_t}{A_{t-1}} \right) - 2S_t - 0.5S_t \left( \frac{CA_t}{CA_{t-1}} \right) + \frac{1}{2} S_t \]

\[ = 2S_t \left( \frac{Y_t}{Y_{t-1}} \right) + 2S_t \left( \frac{A_t}{A_{t-1}} \right) - \frac{1}{2} S_t \left( \frac{CA_t}{CA_{t-1}} \right) - 2.5S_t \]

B.

\[ S_{t+1} = 2(\$500,000)(1.02) + 2(\$500,000)(0.80) - 0.5 (\$500,000)(1.10) - 2.5 (\$500,000) \]

\[ = \$1,020,000 + \$800,000 - \$275,000 - \$1,250,000 \]

\[ = \$295,000 \]

P6.7  Cost Forecast Modeling.  Chandler Bing is product safety manager at Tribbiani-Buffay Products, Inc., a Las Vegas-based producer of data processing equipment.  Bing is evaluating the cost effectiveness of a preventive maintenance program.  Bing believes that monthly downtime on the packaging line caused by equipment breakdown is related to the hours spent each month on preventive maintenance.

A.  Write an equation to predict next month’s downtime using the variables \( D = \) downtime, \( M = \) preventive maintenance, \( t = \) time, \( a_0 = \) constant term, \( a_i = \) regression slope coefficient, and \( u = \) random disturbance.  Assume that downtime in the forecast (next) month decreases by the same percentage as preventive maintenance increased during the month preceding the current one.
B. If 40 hours were spent last month on preventive maintenance and this month’s downtime was 500 hours, what should downtime be next month if preventive maintenance this month is 50 hours? Use the equation developed in Part A.

P6.7 SOLUTION

A. \[ D_{t+1} = a_0 + a_1 M \]

\[ = D_t - \Delta D \]

\[ = D_t - \left( \frac{M_t - M_{t-1}}{M_{t-1}} \right) D_t \]

B. \[ D_{t+1} = 500 - \left( \frac{50 - 40}{40} \right) 500 \]

\[ = 375 \text{ hours of downtime} \]

P6.8 Sales Forecast Modeling. Toys Unlimited Ltd., must forecast sales for a popular adult computer game to avoid stockouts or excessive inventory charges during the upcoming Christmas season. In percentage terms, the company estimates that game sales fall at double the rate of price increases and that they grow at triple the rate of customer traffic increases. Furthermore, these effects seem to be independent.

A. Write an equation for estimating the Christmas season sales, using the variables \( S = \) sales, \( P = \) price, \( T = \) traffic, and \( t = \) time.

B. Forecast this season’s sales if Toys Unlimited sold 10,000 games last season at $15 each, this season’s price is anticipated to be $16.50, and customer traffic is expected to rise by 15% over previous levels.

P6.8 SOLUTION

A. \[ S_{t+1} = S_t + \Delta S \]

\[ = S_t - \Delta S_p + \Delta S_T \]

\[ = S_t - 2(P_{t+1}/P_t - 1)S_t + 3(T_{t+1}/T_t - 1)S_t \]

\[ = -2(P_{t+1}/P_t)S_t + 3(T_{t+1}/T_t)S_t \]
B. \[ S_{t+1} = -2(16.5/15)10,000 + 3(1.15)10,000 \]
\[ = -22,000 + 34,500 \]
\[ = 12,500 \text{ games} \]

**P6.9 Simultaneous Equations.** Mid-Atlantic Cinema, Inc., runs a chain of movie theaters in the east-central states and has enjoyed great success with a Tuesday Night at the Movies promotion. By offering half off its regular $9 admission price, average nightly attendance has risen from 500 to 1,500 persons. Popcorn and other concession revenues tied to attendance have also risen dramatically. Historically, Mid-Atlantic has found that 50% of all moviegoers buy a $4 cup of buttered popcorn. Eighty percent of these popcorn buyers, plus 40% of the moviegoers that do not buy popcorn, each spend an average of $3 on soda and other concessions.

A. Write an expression describing total revenue from tickets plus popcorn plus other concessions.

B. Forecast total revenues for both regular and special Tuesday night pricing.

C. Forecast the total profit contribution earned for the regular and special Tuesday night pricing strategies if the profit contribution is 25% on movie ticket revenues and 80% on popcorn and other concession revenues.

**P6.9 SOLUTION**

A. If Q is the number of moviegoers, then:

\[ \text{Ticket Revenue} = P \times Q \]

\[ \text{Popcorn Revenue} = $4(0.5Q) = $2Q \]

\[ \text{Other Concession Revenue} = $3 \text{ (Popcorn buyers and Other buyers)} = $3(0.8(0.5Q) + 0.4(0.5Q)) = $1.8Q \]
Therefore,

\[
\begin{align*}
\text{Total Revenue} &= \text{Concession Revenue} + \text{Ticket Revenue} + \text{Popcorn Revenue} + \text{Other Revenue} \\
&= P \times Q + 2Q + 1.8Q \\
&= P \times Q + 3.8Q
\end{align*}
\]

B. **Regular Price**

Total Revenue  =  $9(500) + 3.8(500) \\
                 =  $6,400

**Special Price**

Total Revenue  =  $4.5(1,500) + 3.8(1,500) \\
                 =  $12,450

C. **Regular Price**

Profit Contribution  =  0.25($9)(500) + 0.8($3.8)(500) \\
                     =  $2,645

**Special Price**

Profit Contribution  =  0.25($4.5)(1,500) + 0.8($3.8)(1,500) \\
                     =  $6,247.50

Based on these figures, the “Tuesday Night Special” results in a $3,602.50 = ($6,247.50 - $2,645) increase in profit contribution.

**P6.10 Simultaneous Equations.** Supersonic Industries, based in Seattle, Washington, manufactures a wide range of parts for aircraft manufacturers. The company is currently evaluating the merits of building a new plant to fulfill a new contract with the federal government. The alternatives to expansion are to use additional overtime, to reduce other production, or both. The company will add new capacity only if the economy appears to be expanding. Therefore, forecasting the general pace of economic activity for the United
States is an important input to the decision-making process. The firm has collected data and estimated the following relations for the U.S. economy:

Last year’s total profits (all corporations) \( P_{t-1} = $800 \) billion

This year’s government expenditures \( G = $2,000 \) billion

Annual consumption expenditures \( C = $600 \) billion + 0.75\( Y \)

Annual investment expenditures \( I = $1,080 \) billion + 0.9\( P_{t-1} \)

Annual tax receipts \( T = 0.16GDP \)

Net Exports \( X = 0.03GDP \)

National income \( Y = GDP - T \)

Gross domestic product (GDP) \( = C + I + G - X \)

Forecast each of the preceding variables through the simultaneous relations expressed in the multiple equation system. Assume that all random disturbances average out to zero.

**P6.10 SOLUTION**

A. **Investment**

\[ I = $1,080 + 0.9P_{t-1} \]

\[ = $1,080 + 0.9($800) \]

\[ = $1,800 \text{ billion} \]

**Gross Domestic Product**

\[ GDP = C + I + G - X \]

\[ = $600 + 0.75Y + $1,800 + $2,000 - 0.03GDP \]

\[ = $600 + 0.75(GDP - T) + $1,800 + $2,000 - 0.03GDP \]

\[ = $600 + 0.75(GDP - 0.16GDP) + $1,800 + $2,000 - 0.03GDP \]
\[
\begin{align*}
&= $600 + 0.6\text{GDP} + $1,800 + $2,000 \\
0.4\text{GDP} &= $4,400 \\
\text{GDP} &= $11,000 \text{ billion ($11 trillion)} \\
\text{Consumption} \\
\text{C} &= $600 + 0.75\text{Y} \\
&= $600 + 0.75(\text{GDP} - \text{T}) \\
&= $600 + 0.75(0.84\text{GDP}) \\
&= $600 + 0.63($11,000) \\
&= $7,530 \text{ billion} \\
\text{Taxes} \\
\text{T} &= 0.16\text{GDP} \\
&= 0.16($11,000) \\
&= $1,760 \text{ billion} \\
\text{National Income} \\
\text{Y} &= \text{GDP} - \text{T} \\
&= \text{GDP} - 0.16\text{GDP} \\
&= 0.84\text{GDP} \\
&= 0.84($11,000) \\
&= $9,240 \text{ billion}
\end{align*}
\]
CASE STUDY FOR CHAPTER 6

Forecasting Global Performance for a Mickey Mouse Organization

The Walt Disney Company is one of the best known and best managed entertainment companies in the world. As the cornerstone of a carefully integrated entertainment marketing strategy, the company owns and operates the world’s most acclaimed amusement parks and entertainment facilities. Some of the best known and most successful among these are Disneyland, California, and Walt Disney World, Florida—an immense entertainment center that includes the Animal Kingdom, Magic Kingdom, Epcot Center, and Disney-MGM Studios. During recent years, the company has extended its amusement park business to foreign soil with Tokyo Disneyland and Euro Disneyland, located just outside of Paris, France. Disney’s foreign operations provide an interesting example of the company’s shrewd combination of marketing and financial skills. To conserve scarce capital resources, Disney was able to entice foreign investors to put up 100% of the financing required for both the Tokyo and Paris facilities. In turn, Disney is responsible for the design and management of both operations, retains an important equity interest, and enjoys significant royalties on all gross revenues. Disney’s innovative means for financing foreign operations has enabled the company to greatly expand its revenue and profit base without any commensurate increase in capital expenditures. As a result, the success of its foreign operations has allowed the company to increase its already enviable rate of return on stockholders’ equity.

Disney is also a major force in the movie picture production business with Buena Vista, Touchstone, and Hollywood Pictures, in addition to the renowned Walt Disney Studios. The company is famous for recent hit movies such as Beauty and the Beast, The Lion King, and Pearl Harbor, in addition to a film library including hundreds of movie classics like Fantasia, Snow White, and Mary Poppins, among others. Disney employs an aggressive and highly successful video marketing strategy for new films and re-releases from the company’s extensive film library. The Disney Store, a chain of retail specialty shops, profits from the sale of movie tie-in merchandise, books, and recorded music. Also making a significant contribution to the bottom line are earnings from the cable TV Disney Channel. In 1996, the Disney empire grew further with the acquisition of Capital Cities/ABC, a print and television media behemoth, for stock and cash. The company’s family entertainment marketing strategy is so broad in its reach that Disney characters such as Mickey Mouse, Donald Duck, and Goofy have become an integral part of the American culture. Given its ability to turn whimsy into outstanding operating performance, the Walt Disney Company is one firm that doesn’t mind being called a “Mickey Mouse Organization.”

Table 6.7 shows a variety of accounting operating statistics, including revenues, cash flow, capital spending, dividends, earnings, book value, and year-end share prices for the Walt Disney Corporation during the 1980-2000 period. All data are expressed in dollars per share to illustrate how individual shareholders have benefitted from the company’s consistently superior rates of growth. During this time frame, for example, revenue per share grew at an annual rate of 16.3% per year, and earnings per share grew by 12.2% per year. These performance measures exceed industry and economy-wide norms by a substantial margin. Disney employees, CEO Michael D. Eisner, and all stockholders have profited greatly from the company’s outstanding performance. Over the 1980-2000 period, Disney common stock exploded in price from $1.07 per share to $28.94, after adjusting for stock splits. This represents more than a 17.9% annual rate of return, and makes Disney one of the truly outstanding stock-market performers during recent years.
Of course, present-day investors want to know how the company will fare during coming years. Will the company be able to continue sizzling growth, or, like many companies, will Disney find it impossible to maintain such stellar performance? On the one hand, Tokyo Disneyland and Euro Disneyland promise significant future revenues and profits from previously untapped global markets. Anyone with young children who has visited Disneyland or Disney World has seen their delight and fascination with Disney characters. It is also impossible not to notice how much foreign travelers to the United States seem to enjoy the Disney experience. Donald Duck and Mickey Mouse will do a lot of business abroad. Future expansion possibilities in Malaysia, China, or the former Soviet Union also hold the potential for rapid growth into the next century. On the other hand, growth of 20% per year is exceedingly hard to maintain for any length of time. At that pace, the 120,000 workers employed by Disney in 2001 would grow to over 288,000 by the year 2005, and to roughly 619,000 by the year 2010. Maintaining control with such a rapidly growing workforce would be challenging, to say the least; maintaining Disney’s high level of creative energy might not be possible.

Table 6.7 Operating Statistics for the Walt Disney Company (all data in dollars per share)

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenues</th>
<th>Cash Flow</th>
<th>Capital Spending</th>
<th>Dividends</th>
<th>Earnings</th>
<th>Book Value</th>
<th>Year-end Stock Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>$0.59</td>
<td>$0.11</td>
<td>$0.10</td>
<td>$0.02</td>
<td>$0.09</td>
<td>$0.69</td>
<td>$1.07</td>
</tr>
<tr>
<td>1981</td>
<td>0.65</td>
<td>0.10</td>
<td>0.21</td>
<td>0.02</td>
<td>0.08</td>
<td>0.75</td>
<td>1.09</td>
</tr>
<tr>
<td>1982</td>
<td>0.64</td>
<td>0.09</td>
<td>0.38</td>
<td>0.03</td>
<td>0.06</td>
<td>0.80</td>
<td>1.32</td>
</tr>
<tr>
<td>1983</td>
<td>0.79</td>
<td>0.11</td>
<td>0.20</td>
<td>0.03</td>
<td>0.06</td>
<td>0.85</td>
<td>1.10</td>
</tr>
<tr>
<td>1984</td>
<td>1.02</td>
<td>0.13</td>
<td>0.12</td>
<td>0.03</td>
<td>0.06</td>
<td>0.71</td>
<td>1.25</td>
</tr>
<tr>
<td>1985</td>
<td>1.30</td>
<td>0.18</td>
<td>0.12</td>
<td>0.03</td>
<td>0.11</td>
<td>0.76</td>
<td>2.35</td>
</tr>
<tr>
<td>1986</td>
<td>1.58</td>
<td>0.24</td>
<td>0.11</td>
<td>0.03</td>
<td>0.15</td>
<td>0.90</td>
<td>3.59</td>
</tr>
<tr>
<td>1987</td>
<td>1.82</td>
<td>0.34</td>
<td>0.18</td>
<td>0.03</td>
<td>0.24</td>
<td>1.17</td>
<td>4.94</td>
</tr>
<tr>
<td>1988</td>
<td>2.15</td>
<td>0.42</td>
<td>0.37</td>
<td>0.03</td>
<td>0.32</td>
<td>1.48</td>
<td>5.48</td>
</tr>
<tr>
<td>1989</td>
<td>2.83</td>
<td>0.55</td>
<td>0.46</td>
<td>0.04</td>
<td>0.43</td>
<td>1.87</td>
<td>9.33</td>
</tr>
<tr>
<td>1990</td>
<td>3.70</td>
<td>0.65</td>
<td>0.45</td>
<td>0.05</td>
<td>0.50</td>
<td>2.21</td>
<td>8.46</td>
</tr>
<tr>
<td>1991</td>
<td>3.96</td>
<td>0.58</td>
<td>0.59</td>
<td>0.06</td>
<td>0.40</td>
<td>2.48</td>
<td>9.54</td>
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<tr>
<td>1992</td>
<td>4.77</td>
<td>0.72</td>
<td>0.35</td>
<td>0.07</td>
<td>0.51</td>
<td>2.99</td>
<td>14.33</td>
</tr>
<tr>
<td>1993</td>
<td>5.31</td>
<td>0.78</td>
<td>0.49</td>
<td>0.08</td>
<td>0.54</td>
<td>3.13</td>
<td>14.21</td>
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<tr>
<td>1994</td>
<td>6.40</td>
<td>0.97</td>
<td>0.65</td>
<td>0.10</td>
<td>0.68</td>
<td>3.50</td>
<td>15.33</td>
</tr>
<tr>
<td>1995</td>
<td>7.70</td>
<td>1.15</td>
<td>0.57</td>
<td>0.12</td>
<td>0.84</td>
<td>4.23</td>
<td>19.63</td>
</tr>
<tr>
<td>1996</td>
<td>10.50</td>
<td>1.32</td>
<td>0.86</td>
<td>0.14</td>
<td>0.74</td>
<td>7.96</td>
<td>23.25</td>
</tr>
<tr>
<td>1997</td>
<td>11.10</td>
<td>1.51</td>
<td>0.95</td>
<td>0.17</td>
<td>0.92</td>
<td>8.54</td>
<td>33.00</td>
</tr>
<tr>
<td>1998</td>
<td>11.21</td>
<td>1.52</td>
<td>1.13</td>
<td>0.20</td>
<td>0.90</td>
<td>9.46</td>
<td>30.00</td>
</tr>
<tr>
<td>1999</td>
<td>11.34</td>
<td>1.30</td>
<td>1.03</td>
<td>0.00</td>
<td>0.66</td>
<td>10.16</td>
<td>29.25</td>
</tr>
<tr>
<td>2000</td>
<td>12.09</td>
<td>1.58</td>
<td>1.02</td>
<td>0.21</td>
<td>0.90</td>
<td>11.65</td>
<td>28.94</td>
</tr>
<tr>
<td>2004-2006</td>
<td>15.15</td>
<td>2.20</td>
<td>1.05</td>
<td>0.31</td>
<td>1.35</td>
<td>14.75</td>
<td></td>
</tr>
</tbody>
</table>

1 Split-adjusted share prices.
2 Value Line estimates.

Data Sources: Company annual reports (various years), www.valueline.com.
Given the many uncertainties faced by Disney and most major corporations, long-term forecasts of operating performance by industry analysts are usually restricted to a fairly short time perspective. The Value Line Investment Survey, one of the most widely respected forecast services, focuses on a three- to five-year time horizon. To forecast performance for any individual company, Value Line starts with an underlying forecast of the economic environment three to five years hence. During mid-2001 for example, Value Line forecast a 2004-06 economic environment in which unemployment will average 4.4% of the workforce, compared to 4.0% in 2001. Industrial production will be expanding about 3.5% per year; inflation measured by the Consumer Price Index will continue at a modest 2.5% per year. Long-term interest rates are projected to be about 6.6%, and gross domestic product will average over $11 trillion in the years 2004 through 2006, or about 15% above the 2001 total of $9.7 trillion. As Value Line states, things may turn out differently, but these plausible assumptions offer a fruitful basis for measuring the relative growth potential of various firms like Disney.\(^1\)

The most interesting economic statistic for Disney stockholders is, of course, its stock price during some future period, say 2004-06. In economic terms, stock prices represent the net present value of future cash flows, discounted at an appropriate risk-adjusted rate of return. To forecast Disney’s stock price during the 2004-06 period, one might use any or all of the data in Table 6.7. Historical numbers for a recent period, like 1980-2000, often represent a useful context for projecting future stock prices. For example, Fidelity’s legendary mutual fund investor Peter Lynch argues that stock prices are largely determined by the future pattern of earnings per share. Stock prices typically rise following an increase in earnings per share and plunge when earnings per share plummet. Another renown investor, Sir John Templeton, the father of global stock market investing, focuses on book value per share. Templeton contends that future earnings are closely related to the book value of the firm, or accounting net worth. According to Templeton, “bargains” can be found when stock can be purchased in companies that sell in the marketplace at a significant discount to book value, or when book value per share is expected to rise dramatically. Both Lynch and Templeton have built a large following among investors who have profited mightily using their stock-market selection techniques.

As an experiment, it will prove interesting to employ the data provided in Table 6.7 to estimate regression models that can be used to forecast the average common stock price for The Walt Disney Company over the 2004-06 period.

A. A simple regression model over the 1980-2000 period where the Y-variable is the Disney year-end stock price and the X-variable is Disney’s earnings per share reads as follows (t-statistics in parentheses):

$$P_t = -2.311 + 33.296 \text{EPS}_t, \quad R^2 = 89.2\%$$

(1.68) \quad (12.92)

Use this model to forecast Disney’s average stock price for the 2004-06 period using the Value Line estimate of Disney’s average earnings per share for 2004-06. Discuss this share-price forecast.

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\(^1\) See “Economic Series,” The Value Line Investment Survey (www.valueline.com)
B. A simple regression model over the 1980-2000 period where the Y-variable is the Disney year-end stock price and the X-variable is Disney’s book value per share reads as follows (t-statistics in parentheses):

\[ P_t = \$1.638 + \$2.924BV_t, \quad R^2 = 90.9\% \]

Use this model to forecast Disney’s average stock price for the 2004-06 period using the Value Line estimate of Disney’s average book value per share for 2004-06. Discuss this share-price forecast.

C. A multiple regression model over the 1980-2000 period where the Y-variable is the Disney year-end stock price and the X-variables are Disney’s earnings per share and book value per share reads as follows (t-statistics in parentheses):

\[ P_t = -\$1.181 + \$16.980\text{EPS}_t + \$1.655BV_t, \quad R^2 = 97.2\% \]

Use this model to forecast Disney’s average stock price for the 2004-06 period using the Value Line estimate of Disney’s average earnings per share and book value per share for 2004-06. Discuss this share-price forecast.

D. A multiple regression model over the 1980-2000 period where the y-variable is the Disney year-end stock price and x-variables include the accounting operating statistics shown in Table 6.7 reads as follows (t-statistics in parentheses):

\[ P_t = -\$1.052 + \$0.587\text{REV}_t + \$19.172\text{CF}_t + \$0.386\text{CAPX}_t - \$12.651\text{DIV}_t - \$5.895\text{EPS}_t + \$0.183BV_t, \quad R^2 = 97.3\% \]

Use this model and Value Line estimates to forecast Disney’s average stock price for the 2004-06 period. Discuss this share-price forecast.

CASE STUDY SOLUTION

A. Using this simple regression model of stock prices and earnings per share, along with Value Line estimates of Disney’s earnings per share for 2004-06, gives a forecast of $42.64 for Disney’s average stock price for the 2004-06 period:

\[ P_t = -\$2.311 + \$33.296(1.35) = \$42.64 \]

In other words, this forecast means that if stock market investors accord Disney’s 2004-06 earnings per share a price-earnings ratio typical of the 1980-2000 period, and if the Value Line forecast of 2004-06 earnings per share is accurate, Disney’s stock price should grow to $42.64 over a three- to five-year period. From a 2000 year-end base of $28.94, this would represent an average annual rate of capital appreciation of roughly 10.2% per year.
B. Using this simple model of stock prices and book values, along with *Value Line* estimates of Disney’s average book value per share for 2004-06, gives a forecast of $44.77 for Disney’s average stock price for the 2004-06 period:

\[ P_t = 1.638 + 2.924(14.75) = 44.77 \]

In words, this forecast means that if stock-market investors accord Disney’s 2004-06 book value per share a price-book ratio typical of the 1980-2000 period, and if the *Value Line* forecast of 2001-3 book value per share is accurate, Disney’s stock price should grow to $44.77 over a three- to five-year period. From a 2000 year-end base of $28.94, this would represent an average annual rate of capital appreciation of roughly 11.5% per year.

C. Using a multiple regression model of stock prices, earnings per share and book values, along with *Value Line* estimates of Disney’s average earnings per share and book value per share for 2004-06, gives a forecast of $46.15 for Disney’s average stock price for the 2004-06 period:

\[ P_t = -1.181 + 16.980(1.35) + 1.655(14.75) = 46.15 \]

In other words, this forecast means that if stock market investors accord Disney’s 2004-06 earnings per share and book value per share a valuation typical of the 1980-2000 period, and if the *Value Line* forecasts of these numbers for 2004-06 are accurate, Disney’s stock price should grow to roughly $46.15 over a three- to five-year period. From a 2000 year-end base of $28.94, this would represent an average annual rate of capital appreciation of roughly 12.4% per year.

D. Using an extended multiple regression model, along with *Value Line* estimates for 2004-06, gives a forecast of only $41.24 for Disney’s average stock price over the 2004-06 period:

\[ P_t = -1.052 + 0.587(15.15) + 19.172(2.2) + 0.386(1.05) - 12.651(0.31) - 5.895(1.35) + 0.183(14.75) = 41.24 \]

In other words, this forecast means that if stock market investors accord Disney’s 2004-06 accounting operating statistics a valuation typical of the 1980-2000 period, and if the *Value Line* forecasts for accounting performance over the 2004-06 period are accurate, Disney’s stock price should grow to $41.24 over a three- to five-year period. From a 2000 year-end base of $28.94, this would represent an average annual rate of capital appreciation of roughly 9.3% per year. (*Note: High multicollinearity among the independent variables results in high standard errors for the coefficient estimates, and insignificant t statistics. This is despite the fact that many individual variables have the anticipated signs and statistical significance when individually considered in simple regression models. I use this example as a basis for discussing estimation and forecasting problems encountered when using financial data.*)