

## Managerial Economics Forecasting Exercise

Suppose that sales can be forecast either through a linear model or a nonlinear model.

The **linear model** can be expressed as  $S_t = a + b*t$ , where  $t$  is defined as the difference between the year in question and the base year of 1950. A computer regression analysis produced the following estimate of the linear model:

$$S_t = 1.75 + 0.34t.$$

The **nonlinear model** can be expressed as  $S_t = c(1 + g)^t$ , where  $t$  is defined as the difference between the year in question and the base year of 1950 and  $g$  is the growth rate. Using logs, a computer regression analysis produced the following estimates of the nonlinear model:

$$\ln S_t = 0.9177 + 0.0625t.$$

Forecast sales for the years 1973-1976. Follow these steps to determine which model produces better forecasts and why.

First, rewrite the logged equation back into the form  $S_t = c(1 + g)^t$ .  
(Remember that if  $a = \ln(b)$ , then  $b = e^a$ .)

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You will use this equation to forecast sales. What is the growth rate? \_\_\_\_\_

Second, complete the following table for the **linear model**. Actual sales are given under “Y.”

Year	t	Y	F	(Y-F)	(Y-F) <sup>2</sup>
1973		11.9			
1974		13.9			
1975		14.1			
1976		15.7			

Third, calculate the RMSE. \_\_\_\_\_

Fourth, what is the RMSE as a percentage of average sales? \_\_\_\_\_

Fifth, complete the following table for the **nonlinear model**. Actual sales are given under “Y.”

Year	t	Y	F	(Y-F)	(Y-F) <sup>2</sup>
1973		11.9			
1974		13.9			
1975		14.1			
1976		15.7			

Sixth, calculate the RMSE. \_\_\_\_\_

Seventh, what is the RMSE as a percentage of average sales? \_\_\_\_\_

Which model produces better forecasts? \_\_\_\_\_ Why? \_\_\_\_\_

**Managerial Economics**  
**Forecasting Exercise**  
**ANSWERS**

**Linear model**

$$S_t = a + b \cdot t$$

$$S_t = 1.75 + 0.34t$$

**Nonlinear model**

$$S_t = c(1 + g)^t$$

$$\ln S_t = 0.9177 + 0.0625t.$$

First, rewrite the logged equation back into the form  $S_t = c(1 + g)^t$ .  
(Remember that if  $a = \ln(b)$ , then  $b = e^a$ .)

$$\ln S_t = \ln c + t \cdot \ln(1 + g)$$

$$\ln c = 0.9177, \text{ so } c = e^{0.9177}, \text{ and } c = 2.5035$$

$$\ln(1 + g) = 0.0625, \text{ so } (1 + g) = e^{0.0625}, \text{ and } g = 0.0645$$

$$S_t = 2.5035(1.0645)^t$$

You will use this equation to forecast sales. What is the growth rate? **0.0645 or 6.45%**

Second, complete the following table for the **linear model**.

Year	t	Y	F	(Y-F)	(Y-F) <sup>2</sup>
1973	23	11.9	9.57	2.33	5.43
1974	24	13.9	9.91	3.99	15.92
1975	25	14.1	10.25	3.85	14.82
1976	26	15.7	10.59	5.11	26.11

Third, calculate the RMSE.  $\sqrt{\frac{62.28}{4}} = \sqrt{15.57} = 3.945$

Fourth, what is the RMSE as a percentage of average sales?  $3.95/13.9 = 0.2842 = 28.42\%$

Fifth, complete the following table for the **nonlinear model**.

Year	t	Y	F	(Y-F)	(Y-F) <sup>2</sup>
1973	23	11.9	10.54	1.36	1.85
1974	24	13.9	11.22	2.68	7.18
1975	25	14.1	11.95	2.15	4.62
1976	26	15.7	12.72	2.98	8.88

Sixth, calculate the RMSE.  $\sqrt{\frac{22.53}{4}} = \sqrt{5.63} = 2.37$

Seventh, what is the RMSE as a percentage of average sales?  $2.37/13.9 = 0.1709 = 17.09\%$

Which model produces better forecasts? **NONLINEAR** Why? **RMSE IS LOWER**