Building Multiple Regression Models, Chapter 14

Case Study - Virginia Semiconductor

Virginia Semiconductor, Inc., is a leading manufacturer of prime silicon substrates and since 1997 has been the world's number one on-line source for silicon wafers and substrates. The company, situated in Fredericksburg, Virginia, was founded in 1978 by Dr. Thomas G. Digges and his brother, Robert.

Virginia Semiconductor was growing and prospering in the early 1980s by selling a high volume of low-profit-margin wafers in the microelectronic industry. However, in 1985, without notice, the company lost two major customers that represented 65% of its business. Left with only 35% of its sales base, the company desperately needed customers.

Dr. Digges, CEO of Virginia Semiconductor, decided to seek markets where his company's market share would be small, but profit margin would be high because of the value of its engineering research and its expertise. This decision turned out to be a wise direction for the small, versatile company. Virginia Semiconductor developed a silicon wafer that was 2 inches in diameter, 75 microns thick, and polished off on both sides. Such wafers were needed by several customers but had never been produced before. They produced a number of these wafers and sold them for more than 10 times the price of conventional wafers.

Soon the company was making wafers from 2 to 4 microns thick (extremely thin), wafers with textured surfaces for infrared applications, and wafers with micro-machined holes or shapes and selling them in specialized markets. The company was able to deliver these products faster than competitors were able to deliver standard wafers.

Having made inroads at replacing lost sales, Virginia Semiconductor still had to streamline operations and control inventory and expenses. No layoffs occurred, but the average workweek dropped to 32 hours and the president took an 80% pay reduction for a time. Expenses were cut as far as seemed possible. The company had virtually no long-term debt and fortunately was able to make it through this period without incurring any additional significant debt. The absence of large monthly debt payments enabled the company to respond quickly to new production needs.

Virginia Semiconductor improved production quality by cross-training employees. In addition, the company participated in the state of Virginia's economic development efforts to find markets in Europe, Japan, Korea, and Israel. Exports, which were only 1% of the company's business in 1985, grew to over 40%.

The company continues to find new customers because of product development. Virginia Semiconductor has a worldwide distribution network in 29 countries on four continents. Today, SOI (silicon on insulator) substrates are its fastest-growing product. Virginia Semiconductor has received numerous business awards and holds over 15 U.S. patents and trademarks.

Discussion

1. It is often useful to decision makers at a company to determine what factors enter into the size of a customer's purchase. Suppose decision makers at Virginia Semiconductor want to determine from past data what variables might be predictors of size of purchase and are able to gather some data on various customer companies. Assume the following data represent information gathered for 16 companies on **five variables**: the total amount of purchases made during a one-year period (size of purchase), the size of the purchasing company (in total sales volume), the percentage of all purchases made by the customer company that were imports, the distance of the customer company from Virginia Semiconductor, and whether the customer company had a single central purchasing agent. Use these data to generate a multiple regression model to predict size of purchase by the other variables. Summarize your findings in terms of the strength of the model, significant predictor variables, and any new variables generated by recoding.

Size of Purchase ($1000s)	Company Size ($ millions size)	Percent of Customer Imports	Distance From Virginia Semiconductor	Central Purchaser? 0=no, 1=yes
27.9	25.6	41	18	1
89.6	109.8	16	75	0
12.8	39.4	29	14	0
34.9	16.7	31	117	0
408.6	278.4	14	209	1
173.5	98.4	8	114	1
105.2	101.6	20	75	0
510.6	139.3	17	50	1
382.7	207.4	53	35	1
84.6	26.8	27	15	1
101.4	13.9	31	19	0
27.6	6.8	22	7	0
234.8	84.7	5	89	1
464.3	180.3	27	306	1
309.8	132.6	18	73	1
294.6	118.9	16	11	1

2. Suppose that the next set of data is Virginia Semiconductor's sales figures for the past 11 years, along with the average number of hours worked per week by a full-time employee and the number of different customers the company has for its unique wafers. How do the average workweek length and number of customers relate to total sales figures? Use scatter plots to examine possible relationships between sales and hours per week and sales and number of customers. Use Tukey's four-quadrant approach for possible ways to recode the data. Use stepwise regression analysis to explore the relationships. Let the response variable be "sales" and the predictors be "average number of hours worked per week," "number of customers," and any new variables created by recoding. Explore quadratic relationships, interaction, and other relationships that seem appropriate by using stepwise regression. Summarize your findings in terms of model strength and significant predictors.

Average Sales ($ million)	Hours Worked per week	Number of Customers
15.6	44	54
15.7	43	52
15.4	41	55
14.3	41	55
11.8	40	39
9.7	40	28
9.6	40	37
10.2	38	58
11.3	38	67
14.3	32	186
14.8	37	226

3. As Virginia Semiconductor continues to grow and prosper, the potential for slipping back into inefficient ways is always present. Suppose that after a few years the company's sales begin to level off, but it continues hiring employees. Such figures over a 10-year period of time may look like the data given here. Graph these data, using sales as the response variable and number of employees as the predictor. Study the graph in light of Tukey's four-quadrant approach. Using the information learned, develop a regression model to predict sales by the number of employees. On the basis of what you find, what would you recommend to management about the trend if it were to continue? What do you see in these data that would concern management?

Average Sales ($ million)	Number of Employees
20.2	120
24.3	122
28.6	127
33.7	135
35.2	142
35.9	156
36.3	155
36.2	167
36.5	183
36.6	210