# Influence of research on corporate success

Most technically oriented people believe that research activities within a corporation strengthen its performance by leading to new products and by providing leadership to its intellectual life. However, objective evidence of this influence is not readily available. Certainly, no simple "cause and effect" relationships have been found. Indeed, there is no basis for expecting them to exist, because corporate performance depends on several factors in addition to research, so relationships that might actually exist tend to become obscured from view. Also, research generates embryonic activities that take several years to mature. During the long maturation period, the relationships between the original research and the ensuing products become diffused.

In spite of the difficulties cited above, the influence of research can be demonstrated by means of statistical observations. Convenient data are provided by the accompanying list of the 50 manufacturing corporations that did the most spending for research during 1976. This list was first published by *Inside R&D*, Vol. 6, Number 22 (1977). The stock price/earnings ratios (P/E) for these 50 companies are shown along with their research spending/sales ratios (R/S), and their income/sales ratios (I/S).

**Biggest R&D spenders in US industry—1976**

| Rank 1976 | Company | R&D Expend. (Millions $) | R&D/Sales (%) | P/E 1/4/77 | Net 1976 Income/Sales (%) |
|---|---|---|---|---|---|
| 1 | General Motors | 1257.3 | 2.7 | 6.7 | 6.2 |
| 2 | IBM | 1012.0 | 6.2 | 17.4 | 14.7 |
| 3 | Ford Motor | 924.9 | 3.2 | 5.3 | 3.4 |
| 4 | AT&T/Bell System | 643.0 | 1.9 | 10.1 | 11.7 |
| 5 | General Electric | 411.5 | 2.6 | 12.0 | 5.9 |
| 6 | DuPont | 352.5 | 4.2 | 13.6 | 5.5 |
| 7 | United Technologies | 358.4 | 6.9 | 6.9 | 3.0 |
| 8 | Eastman Kodak | 335.5 | 6.2 | 17.1 | 12.0 |
| 9 | Chrysler | 280.0 | 1.8 | 3.4 | 2.1 |
| 10 | ITT | 246.0 | 2.1 | 8.1 | 4.1 |
| 11 | Xerox | 225.7 | 5.1 | 10.7 | 8.1 |
| 12 | Exxon | 202.0 | 0.4 | 8.6 | 5.4 |
| 13 | Boeing | 191.0 | 4.9 | 9.0 | 2.6 |
| 14 | Caterpillar Tractor | 187.9 | 3.7 | 12.4 | 7.6 |
| 15 | Dow Chemical | 187.5 | 3.3 | 11.5 | 10.8 |
| 16 | Sperry Rand | 168.3 | 5.1 | 7.9 | 4.8 |
| 17 | 3M | 157.5 | 4.5 | 17.2 | 9.6 |
| 18 | Union Carbide | 142.4 | 2.2 | 8.0 | 6.9 |
| 19 | Westinghouse | 141.0 | 2.3 | 7.3 | 3.6 |
| 20 | International Harvester | 140.0 | 2.6 | 5.6 | 3.2 |
| 21 | Procter & Gamble | 136.6 | 2.1 | 16.2 | 6.2 |
| 22 | Merck | 136.3 | 8.2 | 16.6 | 15.3 |
| 23 | Honeywell | 125.6 | 5.0 | 9.4 | 4.2 |
| 24 | Goodyear | 113.6 | 1.9 | 11.8 | 2.1 |
| 25 | Eli Lilly | 113.1 | 8.4 | 14.9 | 14.9 |
| 26 | Johnson & Johnson | 112.5 | 4.4 | 19.2 | 8.1 |
| 27 | RCA | 111.9 | 2.1 | 12.5 | 3.3 |
| 28 | Monsanto | 111.2 | 2.6 | 7.5 | 8.6 |
| 29 | Deere | 108.4 | 3.4 | 7.6 | 7.7 |
| 30 | Burroughs | 107.9 | 5.8 | 13.3 | 9.9 |
| 31 | Hewlett-Packard | 107.6 | 9.6 | 23.0 | 8.1 |
| 32 | Gen. Tel & Electronics | 105.64 | 1.6 | 9.0 | 6.7 |
| 33 | McDonnell Douglas | 105.60 | 3.0 | 7.2 | 3.0 |
| 34 | Motorola | 101.5 | 6.7 | 15.0 | 5.7 |
| 35 | Bendix | 100.5 | 3.4 | 8.8 | 3.6 |
| 36 | NCR | 94.2 | 4.1 | 10.5 | 3.9 |
| 37 | Shell Oil | 93.0 | 1.0 | 6.9 | 7.6 |
| 38 | Upjohn | 92.6 | 9.0 | 13.3 | 7.5 |
| 39 | Pfizer | 88.1 | 4.7 | 12.3 | 8.4 |
| 40 | Signal Companies | 83.7 | 3.4 | 8.2 | 2.6 |
| 41 | American Cyanamid | 83.3 | 4.0 | 9.2 | 6.5 |
| 42 | Warner-Lambert | 78.9 | 3.3 | 13.1 | 6.8 |
| 43 | Polaroid | 77.6 | 8.1 | 14.2 | 8.3 |
| 44 | Standard Oil of Calif. | 76.1 | 0.4 | 7.7 | 4.5 |
| 45 | Mobil Oil | 75.0 | 0.3 | 7.5 | 3.6 |
| 46 | Texas Instruments | 72.2 | 4.3 | 20.1 | 5.9 |
| 47 | Celanese | 70.0 | 3.3 | 10.4 | 3.3 |
| 48 | Bristol-Myers | 69.0 | 3.5 | 12.7 | 7.9 |
| 49 | Standard Oil of Ind. | 67.1 | 0.6 | 8.6 | 7.7 |
| 50 | Gulf Oil | 64.0 | 3.3 | 6.8 | 8.6 |

## GUEST COMMENT

by J. J. Gilman
R. H. Miller

The relationship between income and research effort is displayed in figure 1, where I/S is plotted versus R/S for the 50 corporations listed in the table. These corporations make a wide variety of industrial products, and the data of figure 1 scatter considerably as might be expected. Several factors other than research play a role in determining corporate income; and research done in 1977 cannot be expected to have much effect on 1977's income. Nevertheless, the regression line (least squares fit to the data) shows a definite tendency for income to increase with research spending, and the correlation coefficient of 0.45 shows that a statistical connection exists between the two quantities. The slope of the regression line indicates that a one percent increase in relative research spending is related to a 0.65 increase in relative income.

The top 10% of the corporations in relative income (IBM, AT&T, Kodak, Merck, Lilly) all have strong research programs. The bottom 10% (UT, Chrysler, Boeing, Goodyear, McDonnell Douglas, Signal) have modest programs. The 10% with the largest relative research expenditures (Merck, Lilly, Hewlett-

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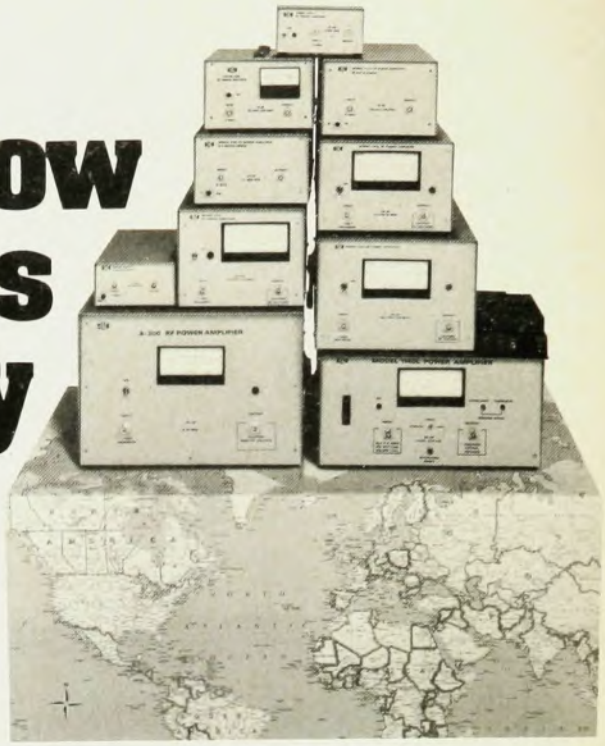

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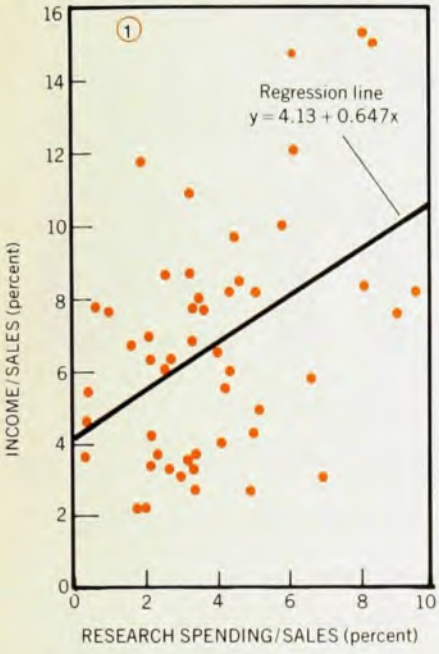
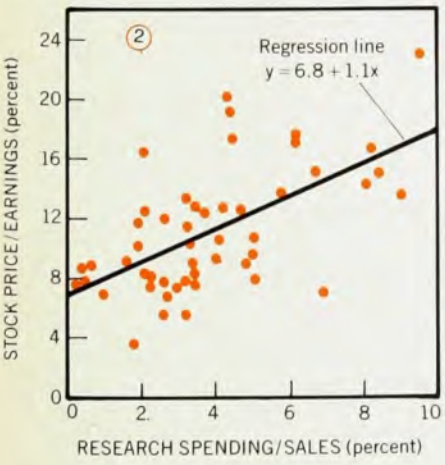
## letters

Packard, Upjohn, Polaroid) have reputations as innovators, so their expenditures have indeed influenced their situations. The 10% with the smallest relative expenditures (Exxon, Shell, Standard of California, Mobil, Standard of Indiana) are uniformly the oil companies and have corresponding reputations as non-innovators. Thus, the data appear to have internal consistency.




The square of the correlation coefficient is a measure of the effect of research spending on the variations in income among the companies of the data set. In this case, the value 0.20 indicates that 20% of the variations can be attributed to research (or lack thereof) while other factors cause the remaining variations. These other factors are such things as: marketing, financial strength, manufacturing efficiency, overhead accounts, and so on.




As mentioned above, there is no good reason to expect a strong correlation between research spending and income because one relates to the present while the other relates to the future. A performance measure that has more future-related content is the price/earnings ratio. It reflects the opinions of analysts (both amateur and professional) regarding the future prospects of corporations. The P/E ratio is determined by other factors as well, but the stature of a corporation's research program is one important factor. This is confirmed by the correlation plot of figure 2, which displays the P/E ratios of the 50 corporations of figure 1 plotted as a function of their relative research expenditures. The correlation is improved in comparison with figure 1. This may be seen by visual inspection and by the increase in the correlation coefficient from 0.45 to 0.59 (a 31% increase).

In figure 2, the regression line indicates that a one percent increase in relative research spending is connected with a 1.1 point increase in the P/E ratio. Also, $r^2 = 0.35$, which may be interpreted to mean that 35% of the variations in P/E ratios among the various corporations is determined by the strengths of their research programs. This is a strong influence indeed!

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## Longest airlift

The recent airlift of a superconducting magnet to Moscow from Chicago (September, page 20) was notable from a standpoint other than that of international scientific cooperation. The flight of a Lockheed C-5 of the United States Air Force included 45 tons of related equipment. Lockheed claims that the 5900-mile flight, which included two refuelings, was the longest in aviation history with a payload that heavy.

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## Oil reserves

In a letter on commodity reserves (October, page 82) Richard Vook points out reassuringly that the known reserves of many minerals (he did not list fossil fuels) have increased dramatically in the years 1950–70 and he says that predicting the life expectancy of any commodity "is probably very difficult, to say the least. Perhaps it isn't even worth the effort."

I feel that it is worth the effort to bring to our students, our teachers and our national leaders an understanding of the easily calculated results of exponential growth in the rate of consumption of a finite resource. The most dramatic example I know follows from the assertion that it is possible to calculate, with considerable accuracy, an absolute upper



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