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R&D: Its Relationship to Company Performance

Graham K. Morbey

Decisions made by management today on investment in research and development can influence the viability and growth of a corporation into the 21st century. Graham Morbey reports on results of this study of R&D spending of major US companies for the ten-year period 1976 to 1985, including possibly controversial inferences concerning the relationship between R&D and company performance. He finds a strong association between R&D spending and subsequent growth in sales. However, he detects a threshold R&D funding level which must be exceeded if R&D is to contribute to future sales growth. The study shows little correlation between R&D intensity and growth in profitability. Also, it is apparent that sales growth and increasing profitability do not lead to increased allocations for R&D in most industries.

We are beginning to see a resurgence in corporate research and development spending similar to that seen during the period 1953 to 1963 [3]. In an era of global competition there is general agreement that technological competitiveness is a vital ingredient for the economic well-being of a business and a nation. What should an organization expect from a significantly increased R&D expenditure?

For a decade the average internally funded R&D spending of major US companies was at a level of 2% of sales or lower. Since 1981 R&D funding has risen steadily. In 1986 the all-industry composite of R&D funding in the United States was 3.5% of sales.

The impact of successful R&D on corporate operations frequently does not show for several years after it appears as an operating cost. Because R&D is an investment that usually does not result in an immediate return, management's decision on the amount of money to be spent on R&D is difficult. Intuitive decisions predominate because there is no precise way to calculate the optimum size for an R&D program. Traditionally, companies in potentially low-growth industries spend little on R&D. Can these decisions preordain industrial maturity and leave companies exposed to technological advances occurring outside the industry?

"You can compete anywhere in the world provided you are willing to risk the R&D money that is required to meet the market needs" says Charles W. Parry, CEO of Alcoa [7], which has significantly increased R&D expenditures in the

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BIOGRAPHICAL SKETCH

Graham K. Morbey is Associate Professor in the Department of General Business and Finance, School of Management, at the University of Massachusetts at Amherst. He is a consultant in technological, production and strategic management. He received his B.S. from the University of Birmingham, England, a master's degree from the University of Toronto and an M.A. and a Ph.D. from Princeton University in chemical engineering. With 25 years industrial experience in production and R&D management with Celanese, Hoechst and Johnson and Johnson, he was Vice President for R&D of Texon before joining the University of Massachusetts.

past few years despite negative profitability of the company. "The paper industry should double its R&D efforts in the next five years and quadruple them in the next ten years" says Alfred H. Nissan, the Tappi Gold Medalist [4]. Such enthusiastic support for R&D by key executives in mature industries is contrary to conventional wisdom and past practice in their industries. However, there is growing evidence that these leaders are correct.

R&D expenditure is only one of many factors which can be important in determining the sales growth and profitability of a company. We might expect, however, that R&D over the long run should be extremely beneficial. In a time-series analysis of sufficient duration we should expect any relationship between R&D expenditures and company performance to become apparent. Using corporate reports for the ten-year period 1976 to 1985, we are now in a position to investigate this relationship at the company and industry level.

R&D Data Base

In 1974 the Financial Accounting Standards Board adopted a standard on accounting for R&D. The standard is specific about what should be listed as an R&D expense. The standard includes costs associated with exploratory research, the costs of modifying or improving current products, the development costs of significantly new products and processes and operating costs of pilot facilities. It excludes routine production testing, quality control costs, market research and market testing costs and legal costs of patient applications and sale and licensing of patents.

Since 1976 R&D costs reported on 10K statements filed with the Securities and Exchange Commission have met a strict definition of these expenses. Therefore, it is possible to compare internally funded R&D intensity of different companies within an industry as well as to compare R&D expenses among various industrial groups.

Although there have been attempts to examine the relationship of R&D expenditure to company performance over a shorter time period [6], it is only now that a full ten years of reliable data are available. Over the period 1976 to 1985, using the data of approximately 800 companies reported by *Business Week* in the Annual R&D Scoreboard [3], based on information reported to the Securities and Exchange Commission on form 10K, it is possible to compare the growth rate of industries and their level of investment in R&D.

Any analysis must recognize the lagged effects of R&D expenditures on company performance. The time lag can vary among industries. It can vary among companies within an industry. It can vary among different R&D projects within a company. Because of this variation, attempts to specify a fixed lag time are futile. However, it can be valid to compare a company's or industry's absolute growth or growth rate over a number of years with the average R&D expenditures for an earlier period. If R&D expenditures for large established companies are measured as a percentage of their sales revenue, the year-to-year variations in R&D expenditures are modest. Therefore, sales growth over a time period can be compared with R&D expenditures of an earlier period without detailed knowledge of the exact lag time of R&D effects. As long as a broad time spectrum is considered the results will be sound.

The Relationship Between R&D and Profitability

Analysis of US industry's R&D spending and profitability over the ten-year period is revealing.

Table 1 gives an all-industry composite picture of the R&D spending intensity of publicly held companies that have sales of at least $35 million and spend at least $1 million or 1% of sales on R&D. Together they probably account for more than 95% of total private sector R&D expenditures.

Table 1 shows that R&D intensity of indus-

Table 1. All-Industry Composite of R&D Intensity and Profitability

Year	No. of companies	R&D expenses (% of Sales)[a]	Profits (% Sales)[b]	Profit and R&D expenses (% of sales)
1986	859	3.5	3.5	7.0
1985	847	3.1	3.9	7.0
1984	820	2.9	5.0	7.9
1983	800	2.6	4.5	7.1
1982	776	2.4	4.2	6.6
1981	776	2.0	5.2	7.2
1980	744	2.0	5.1	7.1
1979	723	1.9	5.7	7.6
1978	683	1.9	5.5	7.4
1977	624	1.9	5.4	7.3
1976	598	1.9	5.5	7.4

[a] R&D expenses measured as percent of sales and other operating revenues.
[b] Profits measured as net income before extraordinary items or discontinued operations as percentage of sales and other operating revenues.

tries, measurd by R&D expenditure as a percentage of sales, has increased since 1981, while reported profitability has declined. In fact, in this all-industry aggregate the ratio of R&D expenditure plus profit divided by sales has been reasonably level for the whole decade. At this level of analysis aggregate R&D intensity is greater when profitability is lower.

The all-industry R&D intensity value for a given year is made up of industries which spend heavily on R&D and industries which spend little on R&D. A number of industries are compared in Table 2.

The computer industry spends heavily on R&D and has consistent growth in profits. The paper industry spends little on R&D and has shown consistent growth in profits. The electronics and chemical industries have similar R&D expenditure intensities with different profit growth rates. Statistical analysis of these data shows there is no correlation between profit growth and R&D expenditure at the industry level.

In a time-series analysis of 460 businesses in the Profit Impact of Marketing Strategy (PIMS) data base, Wagner [8] concluded that companies which consistently spend heavily on R&D as well

Table 2. Industry Analysis: R&D and Profit Change

Industry	R&D Expense (% Sales 1976)	Profits (% Annual Change 1976–1980)[a]	R&D Expense (% Sales 1980)	Profits (% Annual Change 1980–1985)[a]
Computer	5.4	15.2	6.4	15
Drug	4.8	15.0	4.9	9
Aerospace	3.5	28.7	4.5	17
Electronics	2.8	26.8	2.9	9
Chemical	2.6	11.4	2.4	0
Tire and Rubber	1.7	11.0	1.8	6
Appliances	1.1	7.4	1.8	14
Paper	0.8	15.7	0.8	10
Fuel	0.4	27.2	0.4	(9)
All-Industry composite	1.9	19.3	2.0	4

[a] Profit percent annual change = average annual change in net income before extraordinary items.

as on marketing have a better-than-average chance of improving return on investment (ROI). The use of ROI as a measure of R&D effectiveness can be misleading because ROI depends on a measure of net income or profit at a given time. Successful R&D should release a stream of profits over a period of years, but the economic climate and the state of the competitive market may contribute to the growth of profitability and overshadow the influence of a chosen R&D intensity.

Both the Wagner study and the current analysis suggest that the relationship between R&D spending and profitability is tenuous. Therefore, the question as to whether high R&D spenders reap benefits from their expenditures has not been fully answered by studying profitability.

The Relationship Between R&D and Sales Growth

Internally funded R&D activities conducted by industrial companies are used to secure or maintain competitive advantages in a chosen marketplace. A successful R&D effort should influence the company's sales revenue in the long run. This can be achieved by the introduction of new and improved products or processes or by improvement of the company's competitive position with a mature or declining product. While recognizing that many other factors might affect company and industry growth, we would expect successful R&D to play an important role.

The companies in the data bank have been subdivided by *Business Week* into 31 industries. Table 3 lists each industry, giving its average R&D spending over the period 1976 to 1985 as a percentage of sales and the percent annual change in sales over the same period. R&D intensity and percent change in sales revenues are used so that comparisons can be made between industries and companies of different size.

The correlation between the growth rate and average R&D intensity is given in Table 4. Because normality of the data cannot be assumed, the Spearman nonparametric rank-order correlation coefficient has been used to measure association.

The 13 industries which spend more than the all-industry aggregate average R&D/sales ratio of 2.5% have been separated into a research-intensive subgroup, whereas the 18 industries with R&D spending below average are placed in a non–research-intensive subgroup. If we examine these subgroups, we see a very strong correlation between R&D spending and growth rate in research-intensive industries and no correlation between R&D spending and growth rate in non–research-intensive industries.

It is recognized throughout this study that sales growth as reported in a company's financial statement is in terms of nominal, but not real, sales volume. There can be highly differentiated changes in average product prices among industries and even between companies within an industry because of differences in location, raw material supply or inflation. To determine whether inflationary factors might alter conclusions from this analysis, the sales growth of each industry was deflated by appropriate factors based on the producer price index of the industry. The correlation coefficient for the 31 industries using deflated growth figures is 0.59 (t = 3.65) compared with 0.63 (t = 4.37) using reported sales figures. This suggests that in this study inflation has little impact on the correlation between R&D and growth. In addition, when evaluating a multinational company, the application of a deflation factor based on a US standard to describe real sales volume may be misleading because of currency changes. Because deflation adjustments are frequently inappropriate, the sales growth figures in this study are all based on nominal sales as reported on from 10K and on similar company reports. Data comparing industries should be interpreted with this in mind.

Table 3 lists the R&D spending of each industry in 1976 and the spending level in 1985. The third column indicates the R&D intensity of the industry before the sales growth rate listed in the first column had occurred. The R&D intensity given in the fourth column represents the level after the growth period under consideration. Measuring the correlation between the R&D intensity at the beginning of the period and the subsequent growth rate and the correlation between the growth rate and the final R&D intensity is revealing. The correlation coefficients are also given in Table 4.

When we compare the 31 industries as a group, there is a strong correlation between R&D intensity and subsequent growth in sales. In addition, the growth rate correlates strongly with future

Table 3. Relationship Between Industry R&D Intensity and Sales Growth

Industry	Sales Growth 1976–1985 (% Annual Change)	R&D Intensity		
		Average 1976–1985 (% Sales)	1976 (% Sales)	1985 (% Sales)
Aerospace	16	4.0	3.5	4.1
Automotive	7	3.4	2.7	3.5
Chemicals	9	2.9	2.6	3.7
Drugs	10	5.8	4.8	7.8
Electrical	8	2.9	2.6	3.2
Electronics	12	3.3	2.6	4.4
Computers	14	6.6	5.8	7.7
Office Equipment	17	4.9	4.2	6.1
Peripherals	20	5.8	4.4	7.0
Instruments	14	5.4	5.4	6.5
Leisure Time	9	4.2	2.4	5.9
Farm Machinery	4	2.9	3.0	3.0
Semiconductors	18	7.4	5.6	10.7
Appliances	8	1.5	1.1	1.7
Auto Parts	9	1.8	1.7	1.7
Building Materials	9	1.1	1.0	1.3
Conglomerates	10	2.4	1.7	3.6
Containers	3	1.0	1.2	0.9
Food and beverage	8	0.6	0.5	0.8
Fuel	9	0.5	0.4	0.6
Machinery tools	8	2.2	1.9	3.1
Metals and mining	6	1.2	1.2	1.5
Misc. manufacturing	9	2.2	2.0	2.7
Oil service	9	1.9	1.0	3.0
Paper	10	0.9	0.8	1.2
Personal and home care	8	2.0	1.6	2.6
Steel	5	0.6	0.7	0.5
Telecommunications	12	2.4	1.9	4.3
Textile and apparel	6	0.6	0.4	0.8
Tire and rubber	3	2.0	1.7	2.5
Tobacco	7	1.0	0.6	0.4
All-Industry composite	4	2.3	1.9	3.1

R&D expenditures. R&D and sales growth rate are strongly correlated in research-intensive industries. In non–research-intensive industries they are not significantly correlated.

In order to investigate whether R&D expenditures influence subsequent sales growth or whether sales growth influences R&D funding levels, an extension of the technique used by Leonard [2] has been employed. Leonard showed that a causal influence of R&D intensity on rate of sales growth is reflected by a strengthening relationship between sales growth and R&D intensity as the time period under consideration lengthens. A stronger correlation with longer-term growth would result if an increasing proportion of sales was represented by new or improved products from R&D. A corollary is that a causal influence of sales growth on ensuing R&D would require an influence of recent sales growth on R&D intensity stronger than that of previous longer-term sales growth.

Table 5 gives the correlation coefficients be-

Table 4. Correlation Coefficients Between R&D Intensity and Rate of Sales Growth for Industries

Industry Group	Coefficient for: Average R&D Intensity and Sales Growth	Coefficient for: Beginning R&D and Sales Growth	Coefficient for: Sales Growth and ending R&D
31 Industries	0.63[a]	0.63[a]	0.69[a]
13 Research-intensive Industries	0.73[a]	0.57[b]	0.71[b]
18 Non–Research-intensive industries	0.32	0.25	0.39

[a] Indicates significance at 1% level.
[b] Indicates significance at 5% level.

tween the initial (1976) R&D intensity and the sales growth over the first five-year period, 1976 to 1981, and the sales growth for the ten-year period, 1976 to 1985. This comparison shows a strengthening correlation between R&D intensity and subsequent sales growth as the growth period lengthens. The correlation coefficients between sales growth for the most recent period, 1981 to 1985, the sales growth for the ten-year period 1976 to 1985 and the ensuing (1985) R&D intensity are also given. In this case recent sales growth has a weaker correlation with ensuing R&D intensity than previous sales growth. This suggests that the effect of R&D on subsequent sales growth is much stronger than the influence of sales growth on R&D funding.

Table 5. Correlation Coefficients Between Initial R&D Sales Growth and Ensuing R&D Levels

	Coefficient for Initial (1976) R&D Intensity and Subsequent Sales Growth	
	1976–1981	1976–1985
All industries	0.48[a]	0.63[a]
Research-intensive industries	0.46	0.57[b]
Non–research-intensive industries	0.13	0.25
	Sales Growth and Ensuing (1985) R&D Intensity	
	1976–1985	1981–1985
All industries	0.69[a]	0.56[a]
Research-intensive industries	0.71[a]	0.53[b]
Non–research-intensive industries	0.39	0.10

[a] Indicates significance at 1% level.
[b] Indicates significance at 5% level.

In a study of the relationship between R&D expenditure and sales growth of 370 Japanese manufacturing corporations subdivided into 13 industries, Odagiri [5] obtained similar results. The Japanese study showed that there is a positive relationship between R&D and subsequent sales growth of research-intensive industries.

Most industries that have invested heavily in R&D in the past have grown at a fast rate over a sustained period of time. The majority of industries with small R&D expenditures have grown slowly or suffered sales losses in the past five years. This does seem to imply that there is some relationship between technological opportunity, the rate at which industries can grow by exploiting new technology and the funding level an industry selects to invest in R&D. This relationship can be investigated further by examining the actual performance of key companies within different industries.

Individual Company Comparison

Although industry averages can highlight R&D effects, they must be used with caution. The use of aggregate statistics to describe industry performance relative to other industries can be misleading. The placement of a company in the steel or textile or electrical industries may be nothing more than a statistical artifact. Gold [1], in his study of productivity, indicates that an industry can encompass a broad array of plants with

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widely varying operating characteristics and capabilities. Most major companies operate within a number of industries. Because of these problems it was decided to evaluate individual companies in an analysis without regard to industry classification.

Most industries are dominated by a few established companies that set the trend for the whole industrial group. By examination of financial data from the 800 companies over the ten-year period 1976 to 1985, it has been possible to identify 173 large, established companies which had sales greater than $500 million in 1976. Each of these 173 companies existed in recognizable form in 1985. Large companies were studied so that the R&D spending was substantial irrespective of their expenditure level measured as a percentage of sales. No firm studied risked bankruptcy if an R&D project failed. Because acquisitions, major mergers and divestitures over a ten-year period can substantially alter the scale of a business in ways not linked to the consequence of R&D spending, companies were selected that either had minimal acquisition activity or had sales that could be easily adjusted to reflect this activity.

In order to compare the sales performance of an individual company, it is useful to have a standard of comparison which can be applied to all industries. Actual gross national product (GNP) is a standard that fulfills this requirement. For a corporation to be regarded as successful, we might expect that its sales performance should improve with increasing GNP. In Table 6, the 173 companies are segmented into three categories depending on their sales growth from 1976 to 1985. The 55 companies classified as leaders have grown at least as fast as the actual GNP, showing a nominal dollar sales growth greater than 124% over the ten-year period. The 59 companies classified as laggards have grown at less than one half the rate of GNP, showing a nominal dollar sales growth of less than 62% over the ten-year period. The 59 companies with intermediate growth rates are classified as also-rans.

The 173 companies are from 26 industries. Companies classified as leaders are found in 18 industries and laggard companies in 22 industries. Comparison of the actual percentage sales growth of these companies over this ten-year period with their investment in R&D at the beginning of the decade is revealing. Of the 173 companies, 31 companies (18%) invested 4% or more of sales revenue on R&D, while 102 companies (59%) invested 2% or less on R&D.

Table 6. Influence of Company R&D Investment Level on Ten-Year Sales Growth

R&D Expenditure (% of 1976 Sales)	No. of Companies in Sales Growth Category		
	Leaders	Also-Rans	Laggards
4% or greater	17 (55%)	13 (42%)	1 (3%)
3% or greater	23 (48%)	16 (33%)	9 (19%)
2% or less	29 (28%)	33 (33%)	40 (39%)

Companies with expenditures of 4% or more of sales revenues on R&D were sales growth leaders over the ten-year period. There was only a minute chance, 1 in 30, that a company investing at this level of R&D became a sales laggard. Companies spending at least 3% of sales on R&D were mostly sales growth leaders. Less than 1 in 5 (19%) of companies with R&D expenditures over 3% were sales laggards over the ten-year period. Companies spending 2% or less of sales on R&D were mostly laggards in sales growth. Almost three quarters (72%) of companies which chose to invest in R&D at this low level fell into the category of laggard or also-ran companies.

The preceding data suggest that companies which invested a larger percentage of sales in R&D benefited with a greater growth rate than their competitors, irrespective of their industrial classification.

Intercompany Comparison

In order to examine the influence of R&D investment decisions on the growth of rival companies in an industry, a comparison of competing companies within industrial groups has been compiled. The industrial groups range from those which invest heavily in R&D, such as computers, drugs and health care, to lower spending industries such as fuel, metals and mining. Intermediate groups are represented by the electrical, diversified chemicals, household products and tire and rubber industries.

Within these industries competitive companies with similar products are compared in Table 7.

Table 7. The Relationship Between R&D and Sales Growth of Selected Companies

Industry	Company	R&D (1976) (% Sales)	R&D (1985) (% Sales)	Sales Growth (1976–1985) (%)
Drug	Upjohn	9.0	14.1	95
	Lilly (Eli)	8.4	11.3	143
	Merk	8.2	12.0	113
	Schering-Plough	6.2	9.1	121
	Pfizer	4.7	7.1	113
	Squibb	4.1	8.1	68
	Warner-Lambert	3.4	6.5	34
	Sterling Drug	3.3	4.9	60
	American Home Products	2.4	4.6	89
Health Care	Abbott Laboratories	5.5	7.2	209
	Baxter Travenol	5.0	5.4	164
	Johnson & Johnson	4.5	7.3	154
	Becton Dickinson	3.9	5.2	124
	Bristol-Myers	3.5	5.9	123
Metals and Mining	Alcoa	1.6	2.3	77
	AMAX	1.4	0.7	53
	Reynolds Metals	1.1	0.9	64
	Kaiser Aluminum	0.7	0.6	10
	ASARCO	0.4	0.5	6
	Chromalloy America	0.3	0.2	(7)
Fuel	Diamond Shamrock	1.8	0.2	202
	Phillips Petroleum	0.7	0.7	174
	Occidental Petroleum	0.6	0.1	162
	Atlantic Richfield	0.4	0.6	156
	Exxon	0.4	0.8	78
	Ashland Oil	0.3	0.2	93
	Kerr McGee	0.2	0.4	71
	Texaco	0.2	0.4	75
Electrical	AMP	9.0	9.8	213
	Motorola	6.8	8.5	261
	Harris	3.9	5.1	343
	RCA	2.1	2.8	68
	Raytheon	1.9	4.1	160
	Litton	1.7	2.5	36
	N.A. Phillips	1.5	2.3	154
	Singer	0.9	2.4	13
Household products	Proctor & Gamble	2.1	3.0	108
	Colgate Palmolive	0.9	1.8	23
	Clorox	0.6	2.4	29
Tire and rubber	Goodrich, BF	2.1	2.0	65
	Goodyear Tire & Rubber	2.0	3.1	60
	Firestone Tire & Rubber	1.4	2.1	(2)
Information processing computers	Hewlett-Packard	9.7	10.5	485
	Digital Equipment	7.9	10.7	804
	IBM	6.2	6.9	203
	Burroughs	5.8	5.7	169
	Honeywell	5.0	6.8	165
	Sperry	5.0	8.1	75
	Control Data	4.4	8.6	176
	NCR	4.1	6.9	86
	Gould	3.5	10.1	16
Diversified chemicals	Rohm & Haas	4.5	6.0	95
	American Cyanamid	4.0	7.1	69
	Dow Chemical	3.3	4.7	104
	Celanese	3.3	3.4	43
	Monsanto	2.6	7.0	58
	Hercules	2.2	2.9	62
	Union Carbide	2.2	3.1	42
	Olin	1.8	3.0	27

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The R&D expense measured as a percentage of sales for 1976 and 1985 is listed for each company. This R&D expense can be compared with the growth in sales for each company over the ten-year period 1976 to 1985.

Table 7 clearly shows that most companies that have spent a greater percentage of sales revenue on R&D have grown faster than their competitors with more modest R&D expenditures. This is true in faster growing industries, such as computers, wherein Hewlett-Packard and Digital Equipment have outpaced their competitors. It is true in modest growth industries, such as diversified chemicals, wherein Rohm & Haas, American Cyanamid and Dow Chemical have led the growth. It is true in the lower growth metals industry, with Alcoa leading the industry.

The data suggest that companies that invested a larger percentage of sales in R&D benefited with a greater growth rate within their industry than their competitors. Even in mature lower growth industries, the larger spenders outperformed their industry in the long run.

The relationship is examined further by comparing the beginning (1976) R&D investment level, the percentage sales growth over the ten-year period, with the final (1985) R&D investment level of each company within a specified industry. Table 8 gives the Spearman rank correlation coefficients between the R&D intensity at the beginning of the period and the ten-year sales growth and between the growth and the subsequent R&D intensity for 14 industries that contained a sufficient number of companies to be statistically analyzed.

In the majority of industries, we find a strong positive correlation between the R&D intensity of a company at the beginning of the study and its subsequent percentage sales growth in comparison with competitors. The correlation is particularly strong in the drug, health care, chemical, information processing, fuel, metals and mining, electronics and oil service industries. In nearly all cases, the correlation between R&D spending and subsequent growth rate is greater than the correlation between growth rate and the ensuing R&D funding by individual companies. Only in the drug, chemical, metals and mining and electronics industries does corporate growth correlate with final R&D funding intensity. The eight companies in the aerospace industry show no correlation between internal R&D funding intensity and growth. The impact of government R&D funds on individual companies in this industry could change the relationship. The correlation is apparently nonexistent in the paper and food industries. Both of these industries spend little on R&D.

Table 8. Correlation Coefficients Between R&D Intensity and Sales Growth of Companies Within Specified Industries

Industry	No. of Companies	Coefficient for: 1976 R&D Intensity and Ten-Year Sales Growth	Coefficient for: Ten-Year Sales Growth and 1985 R&D Intensity
Computer	9	0.85[a]	0.40
Chemical	15	0.47[a]	0.48[b]
Drug	9	0.67[b]	0.62[b]
Health care	5	1.0[a]	0.30
Aerospace	8	0.12	0.24
Paper	8	0.03	0.05
Fuel	8	0.97[a]	−0.19
Automotive	8	0.36	0.27
Metals and mining	8	0.94[a]	1.0[a]
Electronics	8	0.81[b]	0.79[b]
Food	10	0.25	0.20
Engineering	11	0.30	0.39
Oil service and supply	6	0.72[b]	0.14
Personal and home care	5	0.60	0.40

[a] Indicates significance at 1% level.
[b] Indicates significance at 5% level.

Conclusions

The influence of R&D expenditures as one of the key factors in determining the growth potential of industrial concerns over the long term has been examined.

The analysis suggests that there is no significant relationship between R&D intensity and profitability. At an all-industry aggregate level there appears to be an indication that R&D intensity increases as profitability declines.

There is a strong association between R&D intensity and subsequent growth in sales. The long-term growth leaders in any industry tend to be companies that spend a higher percentage of sales on R&D than their competitors. Industries that

invest modestly in R&D tend to be growth laggards, whereas most industries that invest heavily in R&D grow vigorously.

This analysis over the ten-year period suggests there is a much stronger effect on R&D on growth than that of growth on R&D funding. In most industries there is little evidence to show that increased growth and profits encourage increased allocations for R&D.

Over the period examined, major established companies that invested at least 4% of sales revenue in R&D showed significant sales growth irrespective of industry. Companies that invested 3% or more of sales revenue in R&D had an 80% chance of long-term growth at a rate of at least one half the rate of increase in GNP. Most large industrial companies that were spending less than 2% of sales revenue on R&D did not grow at a rate equal to or better than the GNP. Companies investing in R&D at this low level tended to be sales laggards.

Implications for the Future

Investment in R&D may be one of the key nutrients for an industrial organization. It can be the seed to provide for the successful birth of a new product. It can be the vitamin to keep an industrial company growing. It can be the tonic to keep the mature organization from collapse despite the more limited technological horizons of older industries.

Management can influence the future growth pattern of a company by its R&D investment decisions. A decision to invest in R&D at a level greater than the competition will usually result in a long-term growth rate greater than competitors in the same industry. There appears to be a critical R&D level of 3% sales revenue or greater to ensure reasonable long-term growth. Companies prepared to invest only at lower levels are probably supporting current business but are leaving future growth to chance. If long-term growth is a goal of management, this study suggests that a company must be prepared to invest heavily in R&D. Only with sustained R&D investment is it likely that an enterprise will continue to grow. Perhaps some of our companies and industries are paying today for the cut-back in R&D support in the 1970s. Let us hope the current upward swing in R&D support reflects the realization that R&D investment is vital to most companies. The decisions made by management today will determine whether a company will exist in the 21st century.

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