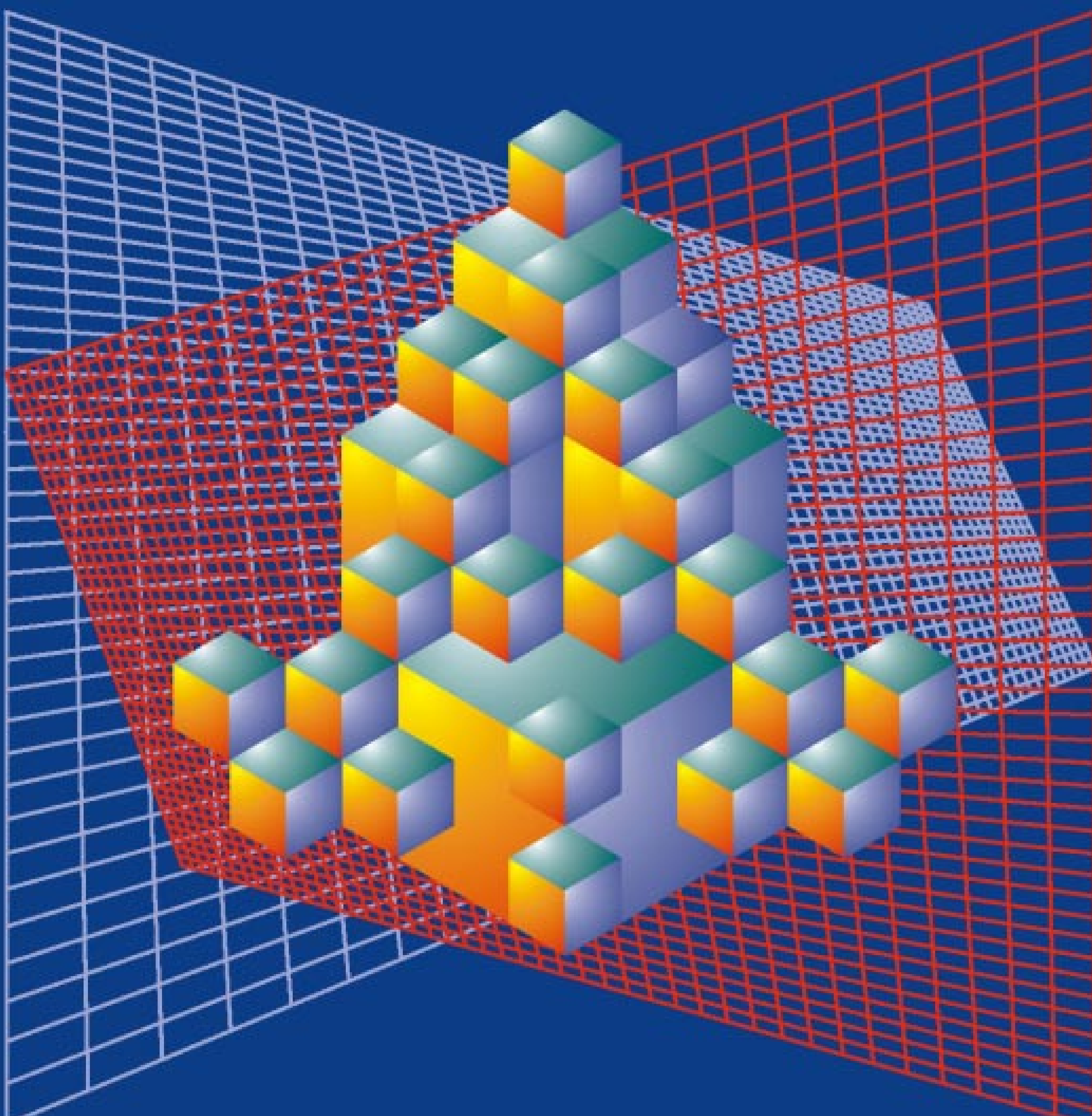
Catalogue no. 88-517-XIB

The Defining Characteristics of Entrants in Science-based Industries

John Baldwin, Joanne Johnson



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John Baldwin, Joanne Johnson

Published by authority of the Minister responsible for Statistics Canada

March 1999

Catalogue no. 88-517-XPB
Frequency: Occasional

ISBN 0-660-60574-0

Ottawa

Note of appreciation

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Canadian Cataloguing in Publication Data

Baldwin, John R. (John Russel)
The Defining Characteristics of Entrants in Science-based Industries

Text in English and French on inverted pages.
ISBN 0-660-60574-0
CS88-517-XPB

1. New Business Enterprises – Canada – Statistics.
2. Science and Industry – Canada – Statistics.
I. Statistics Canada.
II. Title.
III. Title : Les caractéristiques déterminantes des jeunes entreprises des industries scientifiques.

HD62.5 B34 1999 338.4'76'0971'021 C99-988023-3

Acknowledgements

This report is an outgrowth of a larger project that has been examining the characteristics of new firms. Its foundation is the *Survey of Operating and Financial Practices.* While already mentioned previously (in *Successful Entrants: Creating the Capacity for Survival and Growth*) for her superb contribution to the survey, it is important once more to note the contribution made by Christine Hinchley, who was instrumental in helping to develop the survey and in preparing the data base. Joanne Johnson and Bob Gibson generated the data that are used for this report.

The idea for this study initiated with Robin Heilig of the Business Development Bank. I drafted the report, with the aid of Joanne Johnson. Comments on an earlier draft were received from Fred Gault of the Science and Technology Redesign Project. The French and English editors were Suzanne David and Valerie Thibault. The team involved in the design and production of the publication included Francine Simoneau, Valerie Thibault, and staff from the Dissemination Division.

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Preface

This is the fourth in a sequence of studies that have investigated the growth and death process of small and medium-sized firms. The first—*Strategies for Success:* Catalogue No. 61-523R-XPE—provides an overview of the strategies and activities of a group of small- and medium-sized firms that were growing during the last half of the nineteen eighties. It focuses on differences between the faster- and slower-growing firms in the sample and finds that innovation is the key to success. The second study—*Failing Concerns: Business Bankruptcy in Canada:* Catalogue No. 61-525-XPE—investigates the characteristics of firms that are associated with failure. The major findings of this study are that internal and external factors are about equally responsible for firm failure. Internal factors are more important among firms that are less than five years old. The major internal deficiencies, particularly in younger firms, fall in the area of management capabilities. The third study—*Successful Entrants: Creating the Capacity for Survival and Growth* Catalogue No. 61-524-XPE—examines new firms and provides a profile of this group. It examined the competitive environment that they faced, their strengths, and their capital structure. This study revisits many of the same issues, but asks how new firms in a group of R&D-intensive industries differ from new firms in the rest of the economy. It is relevant to those who believe that the R&D sector is driving the economy and that new small firms are the key element in this sector.

Executive Summary

New firms are seen to play a key role in the innovation process. This study examines the differences in the profiles of successful new firms in science-based industries (what are sometimes referred to as knowledge-based industries) versus new firms in other industries.

The firms examined in the study are those that entered the market between 1983 and 1986 and survived to 1996, the year in which the survey was conducted. Since *less than one in five of all start-ups last beyond their tenth year,* these firms are considered relatively "successful" based on mere survival beyond a decade.

The study examines factors that are seen to influence the success of new businesses. These include:

i) the characteristics of the firm and its management;
ii) the nature of the competitive environment faced by the firm and its strategic response;
iii) the firm's competencies and business planning practices; and
iv) the firm's financial planning, type of financing, source of financing and use of funds.

Successful new firms in science-based industries are found to differ in a number of respects from new firms in other industries. These differences exist in the external environment, internal competencies, and financing.

External Environment

- **Competitive Environment:** The differences in the competitive environment faced by the two groups have to do, not so much with numbers of competitors or with the threat of entry, *but with greater uncertainty associated with consumer demand. New firms in the science-oriented sector depend more heavily on a single customer. They are more likely to report that the percentage of business that comes from repeat customers is greater than 50%.* They are also more likely to *feel that their customers can substitute less easily among competing products.* New firms and their customers are tied more closely in science-based industries.

- **Intensity of Competition:** In science-oriented sectors, new firms face greater competition from industry sources with respect to the rate at which *new products are being introduced and products are being customized.* Competition with regards to price, flexibility in responding to customer needs, offering a wide range of products, quality of service and customer service is just as intense, if not more so, in other industries than in science-oriented industries.

- **Stage of Market:** New firms in the science-oriented sector differ only marginally in terms of the stage of the market that they consider themselves to be in. *Most new firms in both groups consider themselves to be in the mature stage of the product life cycle—47% and 51% for science-based and other firms, respectively.*

- **Competitive Strategies:** New firms in the science-oriented sector place more emphasis on *quality and customization of products.* However, new firms in the science-oriented sector and other new firms cannot be differentiated by the emphasis that they place on price, flexibility in responding to customer needs, or customer service.

Internal Competencies

- **Management:** Managers in science-based industries have *less experience in their industry and as a manager in general.* Running these firms requires new types of knowledge. Firms therein have to draw on people who possess new knowledge, who naturally have less experience in managing than others in the economy. Managers in the science-based sector make *greater use of information technology.*

- **Technology and R&D:** New firms in the science-oriented sector place much greater emphasis on the *development of new technology, on R&D capabilities and on the use of intellectual property.* Some 69% of investments of firms in the science-oriented sector consist of knowledge-based assets—20% in R&D, 22% in technology acquisition and licensing, 15% in market development and 10% in training. New firms in other sectors devote only 42% of their investment expenditures to the same categories.

- **Production Processes:** New firms in the science-oriented sector are more likely to focus *on reducing production time and using computer-controlled processes.* There is little difference between the two groups in the extent to which they are improving the efficiency of input use or using high quality suppliers.

- **Innovation:** New firms in the science-oriented sector are *much more likely to innovate (50% as compared to only 21% of the other group).* Innovators in science-oriented industries are much more likely to produce new products, or combinations of new products and new processes. They are less likely to focus on new process innovations. About one-third of innovators in the science-based sector make use of intellectual property rights, compared to 10% of innovators elsewhere.

- **Marketing:** *Science-oriented new firms are more likely to target new domestic and new foreign markets.* As a result, firms in the science-oriented sector are much more likely to be exporters. Some *36% of new firms in the science-oriented sector export outside Canada while only 11% of new firms in other industries do so.* Moreover, if they export, a higher percentage of their sales come from exports—40% on average for new firms in the science-oriented sector compared to only 25% for new firms in other sectors.

- **Human Resources:** New firms in the science-oriented sector place much *greater stress on recruiting skilled employees. They also place more emphasis on the strategy of training employees.* Sixty-three percent (63%) of new firms in science-oriented sectors gave their workers formal training compared to 52% for new firms elsewhere.

- **Financing:** While new firms give greater emphasis to their competencies in a number of areas, there is one major anomaly. Despite the fact that firms in these sectors are often said to have greater problems in accessing capital, new firms in science-oriented sectors give *less emphasis to all three areas of financial management—finding and maintaining capital, financial management, and flexibility in meeting unforeseen circumstances.*

Financing

Financial Planning and Control

- Less than a quarter of new firms in each group have written business plans. Science-oriented new firms are *no more likely to have a business plan* than new firms in other industries. This is also the case for a formal written financial plan.

- Science-oriented new firms give *more importance to non-financial measures of performance (quality standards and growth) and less importance to standard financial measures like debt/equity ratios.* This is in keeping with the notion that science-oriented industries have a more difficult time in quantifying their knowledge assets and, therefore, have to turn more to visible signs of growth for assessment of success.

- New firms in the science-oriented sector are more likely to have their *financial plan reviewed by a board with outside directors.* Those that update their financial plan are more likely to do so annually, which reflects the greater problems that they face with changing consumer tastes and technological progress.

Types of Financing

- New firms in science-oriented industries are much more likely to derive their financing from *retained earnings and share capital.* Some 57% of total financing comes from these sources in science-oriented industries as opposed to only 46% in other new firms. About the same percentage (15%-16%) comes from short-term secured and unsecured loans for both groups. But new firms in science-oriented industries average only 13% of total financing in the way of long-term loans while new firms elsewhere receive some 20% from this source.

Sources of Financing

- Differences in types of financing are mirrored in the importance of the different sources of financing. *Retained earnings and owner managers supply a greater percentage of funds to science-oriented industries.*

- New firms in science-oriented industries are much less likely than other new firms to access funds from banks and trust companies—22% and 35%, respectively.

Conditions Imposed by Lenders

- The percentage of new firms in the two groups that have performance conditions attached by lenders is much the same. But, *new firms in science-oriented industries are more likely to have conditions imposed in the non-financial area than the financial area.* Indeed, for all but the return-on-assets ratio, the percentage of new firms in the other group that have a particular financial measure like revenue growth attached as a condition of lending is greater than in the science-oriented sector. On the other hand, the percentage of new firms in the science-oriented sector having to meet quality standards, delivery dates, or operating performance measures is greater than in other industries.

Matching of Use and Source of Funds

- New firms in science-oriented industries and elsewhere are both most likely to fund R&D expenditures out of retained earnings. But *the proportion of new firms in the science-oriented sector that finances R&D out of retained earnings is much greater than for other industries.* Moreover, new firms in the science-oriented sector are more likely to use investment tax credits for this purpose. In addition, new firms in the science-oriented sector make use of contract financing for R&D expenditures while other new firms do not.

- *Technology acquisition and market development are also primarily financed by share capital* in both groups; however this source is more likely to be used in science-oriented industries. *New firms in science-oriented industries make greater use of share capital and short-term unsecured loans for technology acquisition than do other new firms.* New firms in other industries are more likely to use long-term unsecured loans for technology acquisition.

- *Training expenditures too come primarily from retained earnings,* but new firms in science-oriented industries and other sectors do not significantly differ with regards to the proportion that indicate retained earnings as the source for this expenditure.

- New firms in science-oriented industries generally are *more likely to rely on retained earnings as a source for all of their investments.* The differences between these and other firms are highly significant for knowledge-based investments in R&D, technological acquisition, and market development. But this source of funds is also used more frequently by new science-oriented firms in areas such as machinery and equipment. On the other hand, new firms in science-based industries are *less likely to use secured loans across all categories*—even in areas like machinery and equipment. New firms in science-based industries, therefore, have to rely more on internal funds for investments in knowledge assets and they apparently have to, or prefer to, do the same for investments in areas like machinery and equipment where other firms are more likely to rely on long-term secured loans.

Introduction

Innovation is seen to be important to economic growth. Consequently, interest has been focused on whether innovation is more intense in some sectors than others. Research in this area has tended to focus on the existence and magnitude of these differences across sectors and firms. There are two main strands to this literature.

The first concentrates on whether some industries are more critical to the innovation process than others. For example, Robson et al. (1988) argue that the majority of innovations come from a small core group of industries that create more innovations than others and that disseminate new products to other industries. These core industries are generally characterized by high R&D/sales ratios relative to other industries. Organizations like the OECD have taken to calling these industries the high-tech sectors and providing scoreboards as to how well different countries are doing in these sectors (OECD, 1997).

The second set of studies focuses on whether small or large firms are more important to the innovative process. The Schumpeterian literature has emphasized the importance of large firms. Yet, new small firms are seen by many to be critical for the innovation process. New firms are both contributors to, and catalysts for, the development of technologies, processes and products. The key role that new, small firms play in the innovation process has been described by Rothwell and Zegveld (1982), who argue that new small firms have been the leading innovators in a number of industries—from electronics to biotechnology. In the same vein, Acs and Audretsch (1990) and Audretsch (1995) use U.S. data on innovations and argue that in many industries, small firms are relatively more innovative than large firms.

Together, these themes suggest that new firms may play a key role in the innovation process and that this role may be more important in some sectors than in others. The sector that traditionally garners the focus of attention consists of industries where research and development expenditure is highest. Therefore, we ask whether there are major differences between the profile of new firms in the R&D-based sectors (what is described here as science-based sectors) compared to other sectors. Knowing what these differences are is particularly relevant for those who are attempting to develop programs that aid small new firms, particularly in those R&D-intensive industries that have come to be known as core innovation sectors.

The Issues

In order to understand the differences between new firms in science-based industries and other industries, numerous factors—including the competitive environment, business strategies, and financial structure—are investigated.

In the first instance, we examine differences in the competitive environment that determines the risk faced by science-based and other industries. Several questions are asked: To what extent do firms in science-based industries face more competitors or a greater threat of entry? Are differences to be found in the extent to which firms in science-based industries emphasize competition with regards to prices, quality, customer service, flexibility in serving customer needs, the introduction of new products, or customization? Or is it the uncertainty of the environment—the extent to which products become obsolete, production technology rapidly changes, or consumer demand is unpredictable—that differentiates firms in science-based industries from others?

The competitive environment is only one factor that determines the risk of an industry. The types of activities that are pursued by firms also affect the level of risk. Some internal strategies are more difficult to implement than others. Previous studies have shown that growth is strongly related to whether firms adopt an innovative strategy (Baldwin et al. 1994; Baldwin and Johnson, 1999). Yet, not all firms adopt an innovation strategy. It is difficult to do so. Implementing a successful innovation program requires skills that are difficult to master. To varying degrees, an innovative firm has to develop a research and development strategy, a technology strategy, a marketing strategy for new products, and a human-resource strategy to develop new skills for its workforce. Putting together just the right combination of these strategies for the environment facing a firm is difficult.

We, therefore, ask whether firms in science-based industries are found to be engaging generally in activities that are difficult to master. Are there differences found in the competencies that firms develop—in the stress that firms place on developing management skills, human resources, the types of marketing strategies or the emphasis on finance?

Differences in risk should be manifested by differences in financial structure. Therefore, we investigate whether the financial structure of firms in science-based industries differs from firms in other industries—whether their source of funds and the type of funds differ. We ask whether science-based firms rely more on internally generated funds and whether they receive less from financial institutions. Taken in conjunction with differences in the competitive environment and the internal strategies adopted, the answers to these questions can be used to infer whether firms in science-based industries are riskier and whether they face different financing problems. In addition, we examine the extent to which lenders find it more difficult to monitor science-based firms. To do so, we examine whether conditions attached to loans are more likely to have to focus on the internal operation of the firm—as opposed to simple financial ratios.

Finally, we turn to the connection between the operating strategy and the financial strategy of firms. We ask whether there is a connection between the types of investments made and the sources of funds that are used. Is it the case that the investments in soft assets that result from research and development or training are generally funded from retained earnings and is this more prevalent in science-based industries? If this is the case, science-based industries face two difficulties—they have to engage in riskier forms of investment, and they have to finance them from a source that is less reliable since it is derived from a residual that is highly volatile and dependent on the macro-economic environment.

The structure of this report is as follows. The following section describes the data utilized in the report. Next, we provide an overview of emerging firms.[1] Then we discuss the differences between emerging new firms in science-based industries and the rest of the economy. Finally, we include an appendix on the methodology used for the survey.

[1] For more detail, see Johnson, Baldwin and Hinchley (1997).

New Firms: Data Source for the Study

The data used in this paper are drawn from the *Survey of Operating and Financial Practices of New Firms,* conducted in 1996. The sample consists of firms that were born between 1983 and 1986 and that survived the vicissitudes of infancy to emerge into their early teen years. Since less than one in five entrants lasts beyond its tenth birthday, the surviving group of new emerging firms is relatively successful.

The data from the survey serve to describe the operating and financing practices of new, emerging firms, and the nature of the environment within which they operate. A firm consists of a collection of competencies. It uses these competencies to organize inputs such as labour, capital and materials to produce final products. The core competencies, such as business and financial management, lay the fundamental framework for the firm. The ability of the firm to acquire, allocate and efficiently manage its resources depends on these competencies. A firm's success will also depend critically upon its employees and, therefore, human-resource competencies are a fundamental component of the firm. Complementary competencies are also developed in areas such as marketing, finance, production and technology. Using both core competencies in management as well as complementary competencies in human resources, marketing, finance, and production, a firm develops products, improves production processes and its delivery techniques.

The nature of the competencies required for success differs across industries. In some industries, production techniques are more critical to success, while marketing is more important in others. The nature of competencies that are required for success may also differ as a firm matures and its products progress through the normal life cycle. In the long run, the survival of a new firm depends not just upon its ability to develop an initial product line, but also on its ability to modify, improve and update its product line, improve its proficiency in producing the product line, and increase the attractiveness of its products in the market place. In order to adapt in a world of intense competition, new firms have to draw from a set of core capabilities to develop the next generation of products.

The environment in which the new firm operates adds a final component to this picture. The environment is characterized by the relative power and predictability of customers, competitors and suppliers, and the stability of products and technology. The appropriateness and effectiveness of the competencies required for a firm's survival will depend on its environment.

With this view in mind, the questionnaire for the survey was designed to obtain a broad overview of the financing and operating practices of emerging firms in each of the areas described above. The questionnaire contains several sections. The first section includes questions pertaining to characteristics of management—the extent of the managerial and industry experience of managers, and their time with and ownership in the firm. Section two contains questions regarding the nature of the competitive environment faced by the firm. The third section contains questions on firm competencies and business planning. The fourth section has questions on financial planning and structure. The final question links operating and financing practices together: respondents are asked to indicate how various activities were financed. Many of the questions were initially derived from previous questionnaires, notably the 1992 *Survey of Growing Small and Medium Sized Firms*[2] and the 1993 *Survey of Innovation and Technology*[3], both of which were conducted by Statistics Canada.

Before detailing what is special about new firms in science-based industries, we provide a brief overview of new entrants in all industries combined. More detail can be found in Baldwin and Johnson (1999).

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[2] See Baldwin et al. (1994).
[3] See Baldwin and Da Pont (1996).

An Overview of Emerging Firms in all Sectors

New emerging firms are typically located in mature markets. In addition, they face a relatively competitive environment. Emerging firms face intense competition from a number of areas: the majority of firms have between 5 and 19 competitors; new competitors are a constant threat; consumers can easily substitute among products. Competition at the industry level is most intense with respect to price, quality and customer service. Most emerging firms depend to some degree on revenue from repeat customers; almost three-quarters of emerging firms depend on repeat customers for 50% or more of their revenues. However, none of these customers individually accounts for a large proportion of revenues, as less than one in five firms depends on one customer for more than 50% of their revenue.

New emerging firms seek to develop a strong set of core competencies. They place a high value on management and financing strategies, and they monitor their performance using concrete quantifiable measures. However, they place less emphasis on measures that the financial community usually stresses in assessing firms, such as return on assets, sales and equity, and debt/equity ratios. Formalized business and financial planning is undertaken by less than one in five firms. This lack of financial planning may in part explain the exceptional dependence of individual firms on a limited range of types and sources of capital, despite the fact that *on average*, the financial structure of emerging firms may seem quite reasonable.

Emerging firms devote a great deal of attention to human resources. In general, human-resource strategies are generally considered to be among the most important strategies to a firm's success, and over half of emerging firms engage in training.

Less value is given to developing technical abilities. Emerging firms report that technology and R&D strategies are of less importance to their overall success. Not surprisingly then, these firms only infrequently engage in R&D, and only slightly more than one in five emerging firms innovated over the 1992 to 1994 period, while a third of these firms invested in acquiring technology.

The emphasis on human as opposed to technical capabilities suggests that these firms will focus on product-specific capabilities that are non-technically oriented. It also suggests that firms will take a more cautious approach to developing their product-specific capabilities, as technically oriented firms have typically been more aggressive in all areas (Baldwin and Johnson, 1996b). Indeed, this is the case. New emerging firms tend to focus on improving their existing product line rather than extending it. They tend to concentrate on increasing the efficiency of their existing processes, rather than introducing radical new types of computer controlled processes. Finally, new emerging firms seek to improve the way they deliver their existing products to their existing customers, rather than to capture new customers.

This overview hides considerable differences between the characteristics of new firms in different sectors of the economy. For example, firms that are operating in highly competitive markets with considerable uncertainty require longer term more permanent forms of capital and their capital structure reflects this (Johnson, Baldwin and Hinchley, 1997). These earlier results strongly suggest that the environment affects the nature of the policies that successful entrants have to adopt in order to survive and grow. In the next section, we extend our previous analysis to examine whether a sector's emphasis on R&D and science also differentiates the firms contained therein in terms of the nature of the strategies that are pursued, the competencies that are developed, and the financial structure that emerges.

Differences Between Firms in Science-based Industries and Other Sectors

In order to study the differences between new firms in science-based industries and all other industries, we had to adopt a scheme to identify science-based industries. Two types of information were used for this purpose—data on R&D intensity of industries and on the extent to which professionals, like scientists and engineers, make up a substantial proportion of the workforce.

The classification technique is basically that used by Lee and Haas (1996), who divide industries on the basis of three R&D measures—the R&D-to-sales ratios, the proportion of R&D personnel to total employment, and the proportion of professional R&D personnel to total employment—and three measures of human capital—the ratio of workers with post-secondary education to total employment, the ratio of knowledge workers[4] to total employment, and the ratio of the number of employed scientists and engineers[5] to total employment. Industries were then assigned to the R&D/scientific category if they fell in the top third on the basis of two of the R&D indices *and* two of the human-capital indices.

Since the classification technique essentially depends upon R&D intensity and the proportion of employment that consists of scientific personnel, we refer to it here as dividing our universe into those industries that are more and less science-based. Others have used the term 'high' and 'low' knowledge-based to distinguish between these two groups of industries. But since the concept of knowledge encompasses many more facets than simply the science-base of an industry[6], we prefer to use the less emotive terminology adopted here. The industries that make up the science-based group are listed in Appendix B.

In the remainder of this section, we summarize differences between new emerging firms in the science-based industries and other industries. This is done by examining the responses of new emerging firms in the science-based sector and comparing them to new emerging firms in other industries. While a dichotomous classification scheme is used here, it is important to remember that not all firms in science-based sectors are high-tech or high-R&D performers. Similarly, not all firms in other sectors are low-tech. Related work (Baldwin and Gellatly, 1998b) discusses this issue at greater length. High-tech firms can be found in almost every industry—but to varying degrees. For the purpose of this paper, we focus not

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4 Occupations in the natural sciences, engineering and mathematics, in education, managers and administrators, social sciences, law and jurisprudence, medicine and health, and writing.

5 Occupations in the natural sciences, engineering and mathematics.

6 See Baldwin and Gellatly (1998a) for a discussion of a more comprehensive taxonomy of the knowledge characteristics of industries.

Figure 1
Competitive Environment

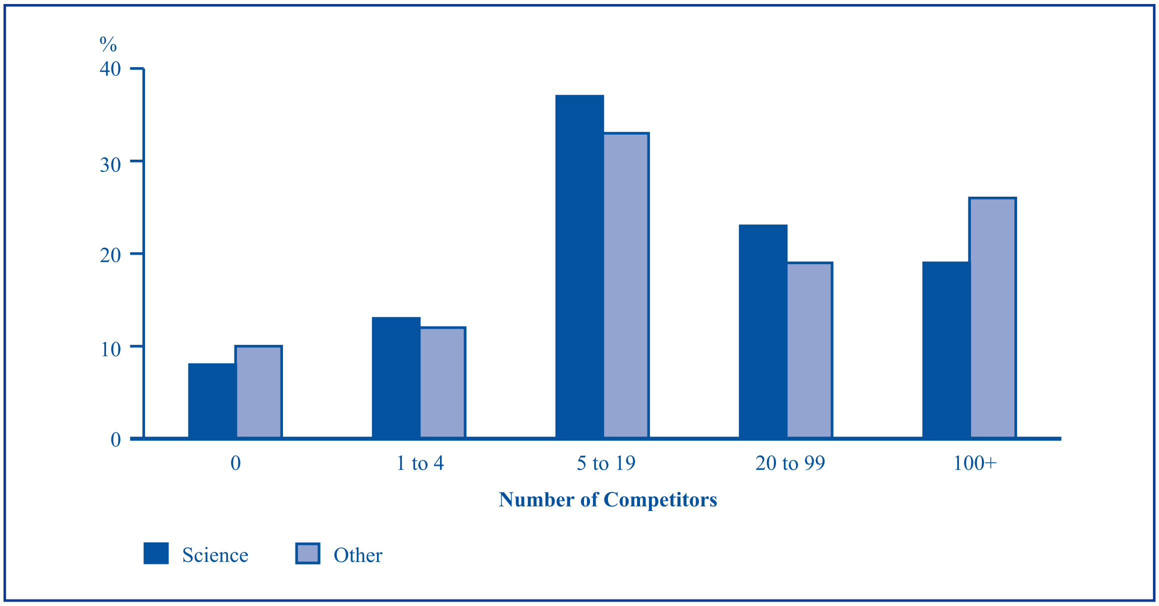
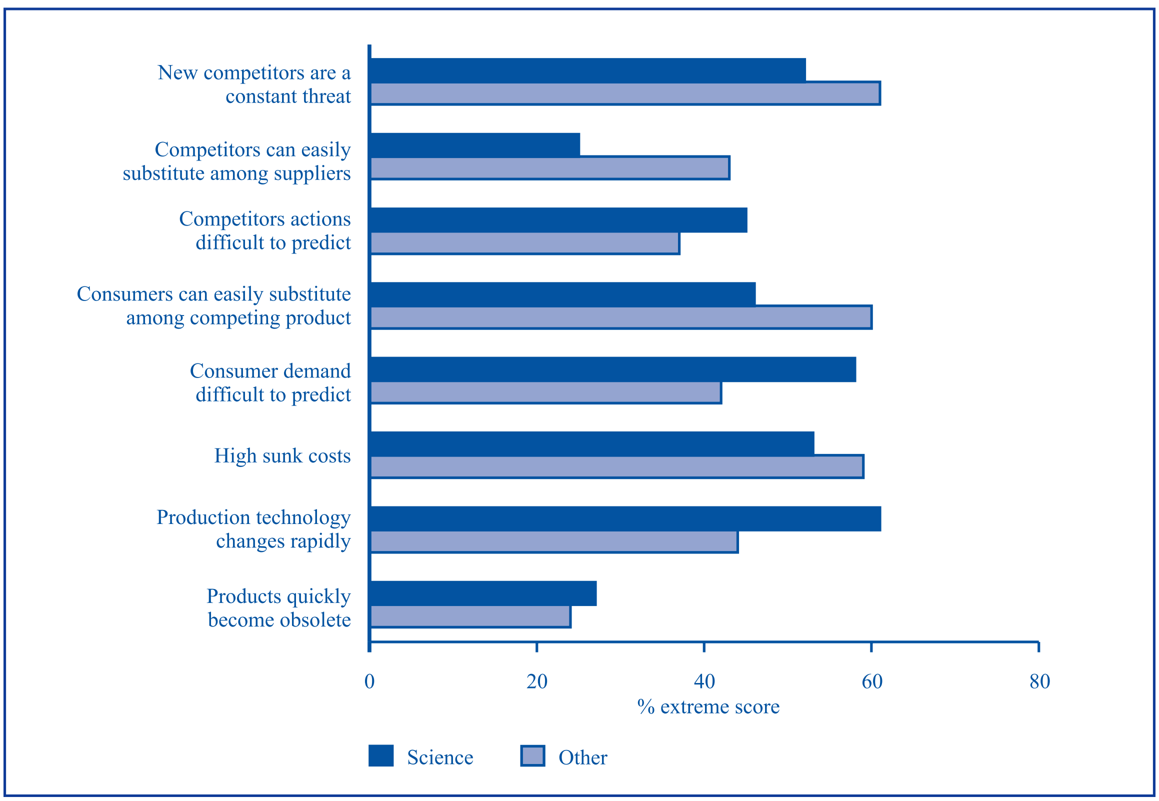


Figure 2
Sources of Uncertainty



on high-tech or high-R&D firms directly—rather on the constituent industries that have a concentration of these firms based on aggregate R&D/sales ratios and the proportion of scientific personnel contained therein.

The responses to the survey are reported in Appendix A, which contains the distribution of responses by category—that is for a question that ranks the importance given to financial factors on a scale of 1 to 5, we report the percentage of firms in each category. For the purpose of comparison across groups described in the remainder of this paper, we examine the percentage of firms that score either 4 or 5—what are frequently referred to as extreme scores since it captures those who choose the upper extreme. By focusing on this group, we can compare industry groups by the percentage in each who give a great deal of importance to a particular strategy or competency. In the text, we refer in various places to whether differences that exist are statistically significant. The level of significance used is 5%. All tests take into account the sampling design of the survey.

Environment

The environment faced by firms determines the nature of competition as well as the risk faced by industry participants.

Evidence on the state of competition in an industry can be derived from two sources. First, it can be inferred indirectly from the size of participants and the number of competitors a firm faces. Industries with larger numbers of small firms are often presumed to fulfill the preconditions for atomistic competition. However, measures such as average size of firm and numbers of competitors are only proxies for competition and there is considerable debate about their accuracy. Second, the state of competition can be derived more directly from a number of market characteristics such as the extent to which technology is changing and products are becoming obsolete, the threat that new entrants offer, and the degree to which consumers have the ability to easily switch from supplier to supplier.

In terms of firm size, there is little difference between firms in the two groups.[7] The average firm in science-based industries has sales of $1.8 million, while those in other industries are slightly smaller at $1.6 million. On the other hand, the average firm in the science-based sector has slightly more employees—there is a slightly greater proportion of these firms in the 10 to 24 employee size class and slightly fewer in the 1 to 9 employee size class. But the differences here are not statistically significant.

There is also little difference in terms of the number of existing competitors. The distribution of the percentage of firms that face 1 to 4, 5 to 19, 20 to 99 and more than 100 competitors is quite similar in the two sectors (Figure 1). On the basis then of both average size and number of competitors, there is little difference between the two sectors.

[7] See questions F1 and G1 of the questionnaire.

FIGURE 3

Intensity of Industry Competition

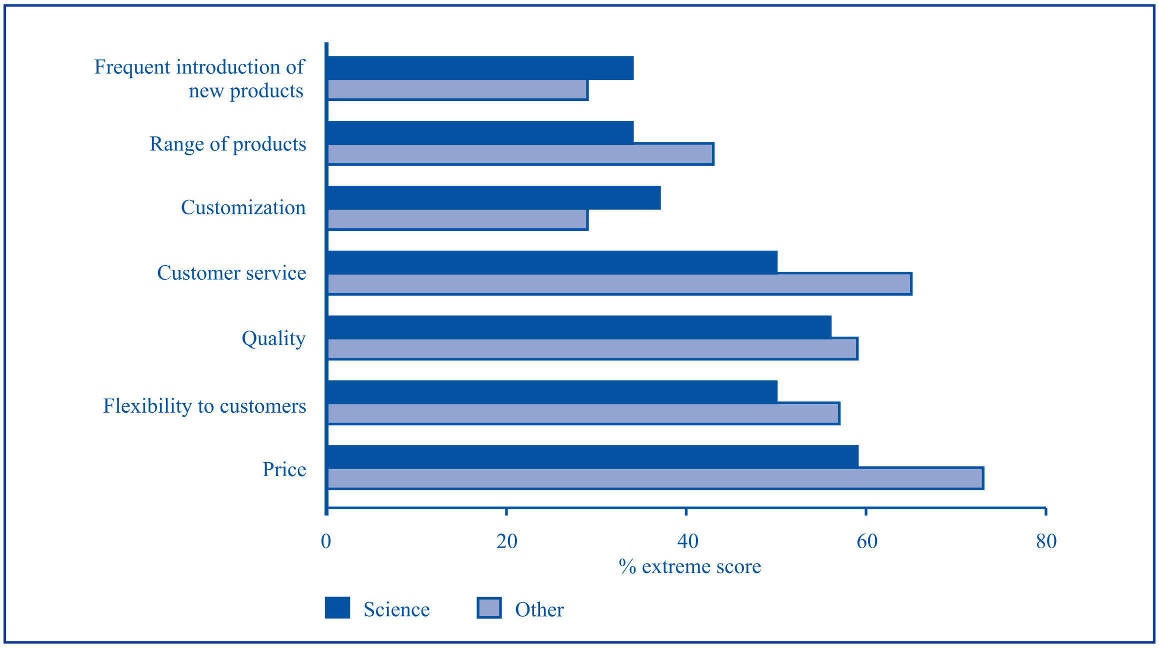
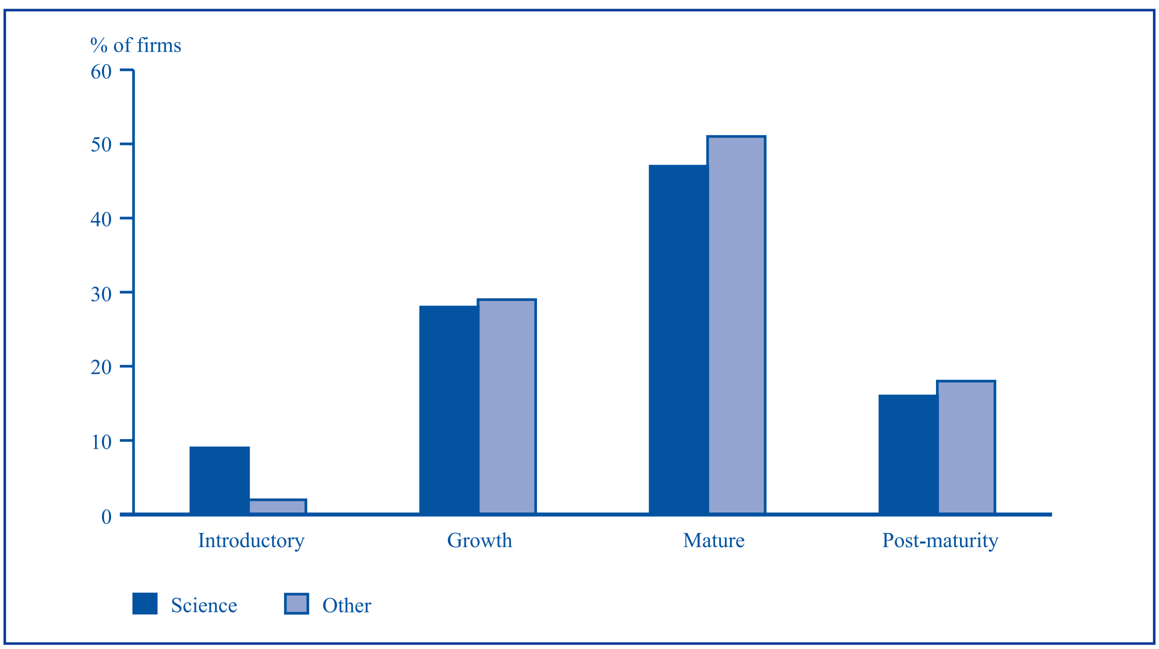


FIGURE 4

Stage of Product Market



However, the competitive environment faced by a firm is also affected by a number of other factors—the threat of entry, and the extent to which firms face single customers who can easily switch to other suppliers, whether consumer demand is difficult to predict, whether competitors actions are easy to anticipate.[8]

In two areas, new firms in the science-based sector face significantly less uncertainty (Figure 2). First, firms can substitute less easily among suppliers. Second, consumers are less able to substitute among competing products. It should be noted that this means that emerging firms in science-based industries face a different type of risk as a result. If substitution is limited, whether it is by suppliers or consumers, interdependencies force firms that are tied together in the vertical chain to rely more on one another since one weak link in the chain can have deleterious consequences for all members of the chain.

In several of other dimensions, there is no significant difference between the two groups. The threat due to new entry and the extent to which products become obsolete is not significantly different in the two groups (Figure 2).

The significant differences between the two groups have to do, not so much with numbers of competitors or with the threat of entry, but with a particular type of greater uncertainty associated with consumer demand. Emerging firms in the science-based sector depend more heavily on a single customer.[9] Over 83% of firms in science-based industries report that at least 10% of total revenues come from a single customer versus 46% in other industries. Firms in the science-based sector also indicate that consumer demand is significantly more difficult to predict. This greater reliance on a smaller number of customers whose behaviour is more difficult to predict produces greater uncertainty in their product markets.

On the production side, firms in science-based industries are significantly more likely to face technological change. Although they face no greater sunk costs, technological obsolescence threatens high losses for those who miscalculate. The fact that they are less able to substitute across suppliers causes additional difficulties. Conversely, a high degree of substitutability in the product market and entry of new competitors drive other industries.

In the previous section, we have described the state of competition by focusing on the environment—the conditions that are mainly exogenous to the firm. But the state of competition also depends upon the behaviour of firms. The strategies chosen by industry participants affect the amount of competition by choosing the intensity of rivalry in a number of dimensions—with regards to price, quality of product, and frequency of introduction of new products.

Is there a difference in the extent to which emerging firms in the two sectors compete? How do firms react to these environmental differences in terms of types of competition? The answer is that they react in quite similar ways across a wide range of strategies. The intensity of competition in their industry with regards to flexibility in responding to customer needs,

[8] See questions in Section B of the questionnaire.
[9] See question G3 of the questionnaire.

offering a wide range of products, and quality, is not significantly different in the two groups (Figure 3). It is higher with regards to customization and the frequent introduction of new products in the science sector but the differences are not significant. It is significantly less intense in science-based sectors with regards to price and customer service. The greater emphasis on customization and the weaker emphasis on price is consistent with the finding that customers are tied more tightly to their suppliers in science-based industries.

In summary, the science-based industries are characterized by a system that is more interdependent, consisting of a web of suppliers and customers. In this system, no one party can switch to others as easily as occurs in other industries. This greater dependency has both advantages and disadvantages. On the one hand, it enhances the importance of shared goals and encourages collaborative efforts. On the other hand, firms become more vulnerable to changes in other firms. The fact that production technology changes rapidly in the science sector exacerbates this problem. Finally, the intensity of competition tends to be less with regards to traditional strategies like price and service competition but more intense in areas related to new product introduction and customization.

Stage of the Market

The product life cycle is often depicted as involving an early stage of rapid growth, then a transition stage, and finally a mature stage. Because science-based firms are often regarded as being a critical part of the knowledge economy and, in turn, the knowledge economy is characterized as being 'new', we might expect science-based firms to be associated primarily with the early growth stages of a product while other sectors are more heavily concentrated in older more mature products.

In contrast to expectations, emerging firms in the science-based sector and elsewhere differ only marginally in terms of the stage of the market that they consider themselves to be in (Figure 4). Admittedly, 9% of firms in the science-based sector consider themselves in the introductory stage of the market while only 2% of firms elsewhere do so. Nevertheless, a majority of firms in both groups consider themselves to be in the mature stage of the product life cycle—47% and 51% for science-based and other firms, respectively.

Competitive Strategies

Competitive strategies can be broken into two groups—the type of product strategy employed (the *what*) and the method used (the *how*). The type of product strategy is determined by the general emphasis placed on price competition, new product introduction, quality and customer service. Success here depends upon what firms do internally—via competencies developed in management, production, marketing, human resources and finance.

a) What do they do in the way of general product strategies?

Emerging firms in the science-based sector and elsewhere generally place the same relative emphasis on the importance of different strategies. Quality, customer service and flexibility in responding to customer needs are the three most important product strategies pursued by both groups of firms. Where significant differences occur, they are in the strategies that are given a lower ranking. Emerging firms in other industries place a significantly higher emphasis on price as a product strategy. Emerging firms in the science-based sector place significantly more emphasis on customization of products.[10]

These differences accord with the differences found in the competitive environment. New firms in science-based industries feel that their customers are less likely to switch from one supplier to another and are not as tempted to employ price as a competitive weapon to accomplish this. On the other hand, they are significantly more likely to customize products so as to keep existing customers and to attract new customers—and to a lesser extent are more likely to use high quality and the frequent introduction of new products to try to keep their existing customers.

b) How is this accomplished?

Management

Previous research (Baldwin and Johnson, 1996b) has demonstrated that innovative small- and medium-sized firms place greater stress on developing their competencies in a wide range of areas, relative to other firms. The more innovative firms generally place greater importance on functional areas that are as diverse as production, R&D, marketing and human resources. This requires considerable management skills.

In most instances, these skills come from experience. In both groups of industries, most of the managers of new emerging firms have worked for the firm for more than 10 years (firms in the survey were 10-14 years old). Nevertheless, the percentage that do so is significantly lower in the science-based industries than elsewhere (68% versus 85%, respectively). It is also the case that managers in these industries have significantly less experience in their industry and as a manager in general. This accords with the view that running these firms requires new types of knowledge, and firms therein have to draw on people who possess new knowledge, who naturally have less experience in managing than others in the economy.

The managers in science-based industries are also slightly less likely to have an ownership position in the firm than in other industries (72% versus 80%, respectively), but those that do so are more likely to have started the firm themselves (79% versus 69%, respectively).

[10] See question C4 of the questionnaire.

Figure 5
Importance of Management Strategies

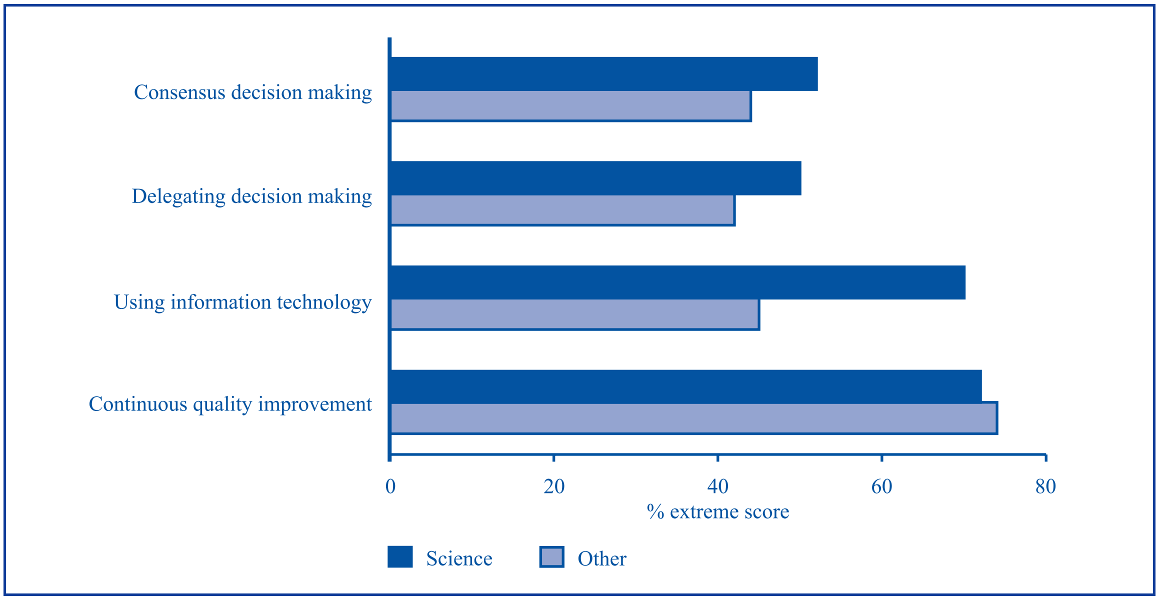
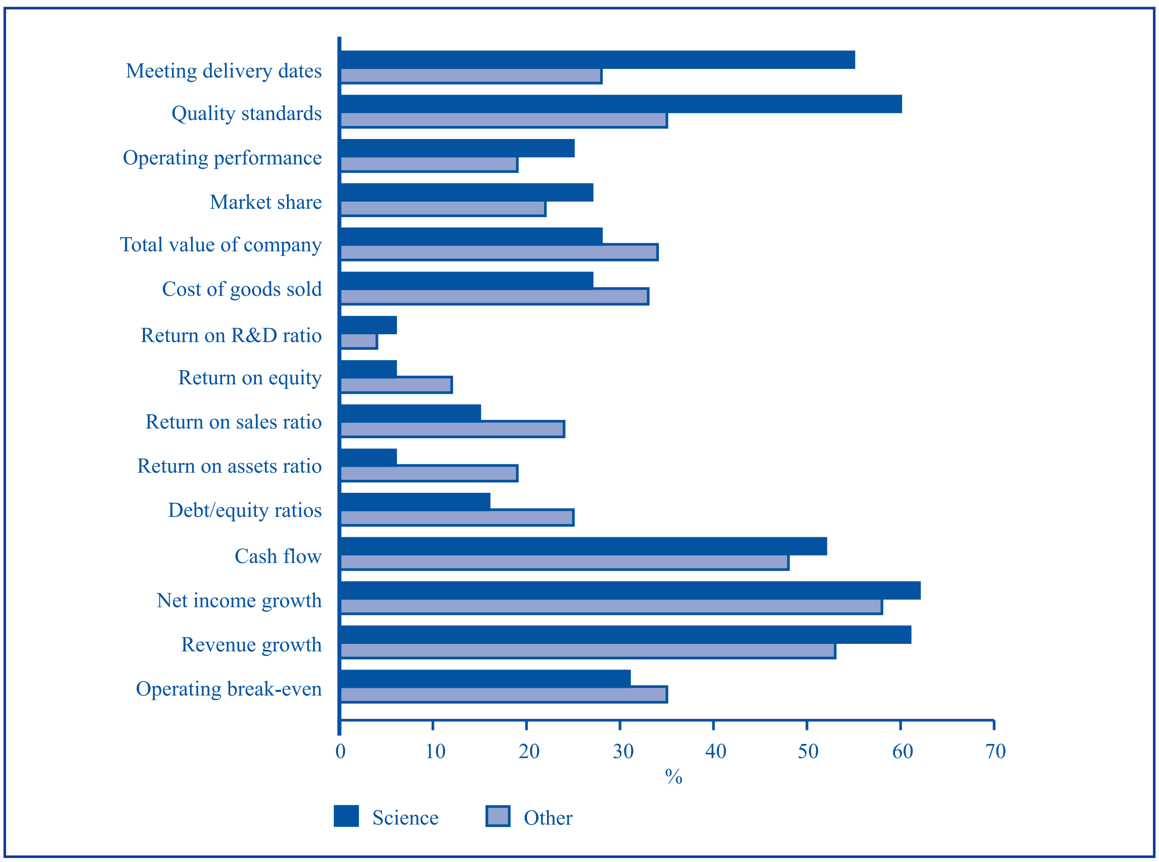


Figure 6
Internal Assessment Criteria



Thus, the population of firms in the science-based sector divides itself into two groups. The first looks more towards bringing in professional managers without ownership participation as they grow; the second consists of those firms where managers have ownership and where they stay longer with the firm than they do in other sectors of the economy, probably because their knowledge is key to success and it is not easily transferable to others.

Firms in the two sectors are different not just in the make-up of their managerial team, but so too in the emphasis they place on management strategies (Figure 5). New firms in the science-based sector differ primarily in the extent to which they stress the use of information technology.[11] Fully 70% of new firms in the science-based sector indicate that using information technology is very important or crucial to their success, significantly more than the 45% of firms in other sectors that rank this strategy as being important. New firms in the science-based sector also place greater emphasis on consensus decision making and delegating decision making, though here the differences are not statistically significant. Both groups give about equal emphasis to continuous quality improvement.

One characteristic that is said to be essential to success is the planning process. The preparation of a formal business plan is often stressed; however, relatively few firms in either sector have written business plans.[12] There is little difference in the periodicity with which the plans are updated.[13]

In spite of the finding that new emerging firms do not engage in formalized planning, they do monitor their performance. In the interest of assessing their performance, new firms in science-based industries tend to stress non-financial ratios like meeting quality standards or delivery dates significantly more and financial ratios (like debt/equity, return on assets, return on sales, and return on equity ratios) significantly less than new firms in other industries (Figure 6).[14] This is in keeping with the notion that new emerging firms in science-based industries have a more difficult time in quantifying their knowledge assets and, therefore, have to turn more to visible signs of growth.

Innovation

New firms in the science-based sector were seen to focus slightly more on introducing new products and offering a wide range of products and to focus significantly more on customization. These differences are reflected in significantly more innovation. New firms in the science-based sector are much more likely to innovate (50% as compared to only 21% of the other group). Within the innovator class, firms in science-based industries are more likely to produce new products, or combinations of new products and new processes than firms in other industries. Within the group of science-based firms, they are less likely to focus on new process innovations than new product innovations. They are also less likely to focus on process innovations than firms in other industries.

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[11] See questions in Section C5 of the questionnaire.
[12] See question C1 of the questionnaire.
[13] See question C2 of the questionnaire.
[14] See question C3 of the questionnaire.

Figure 7
Importance of Technology Strategies

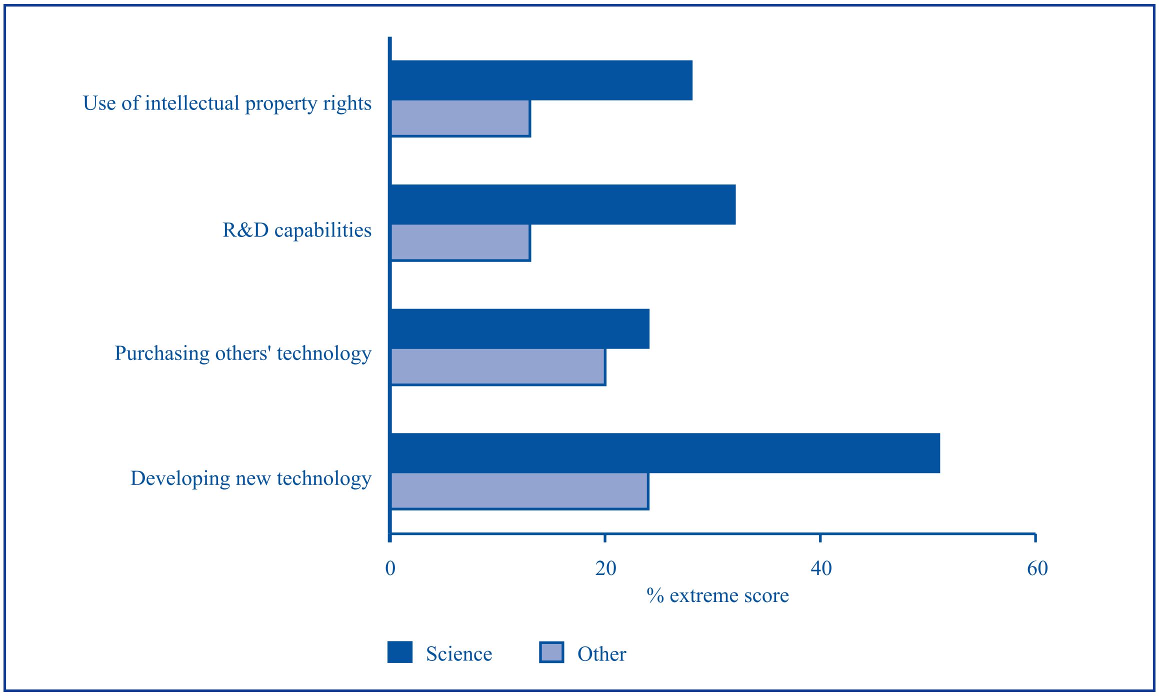
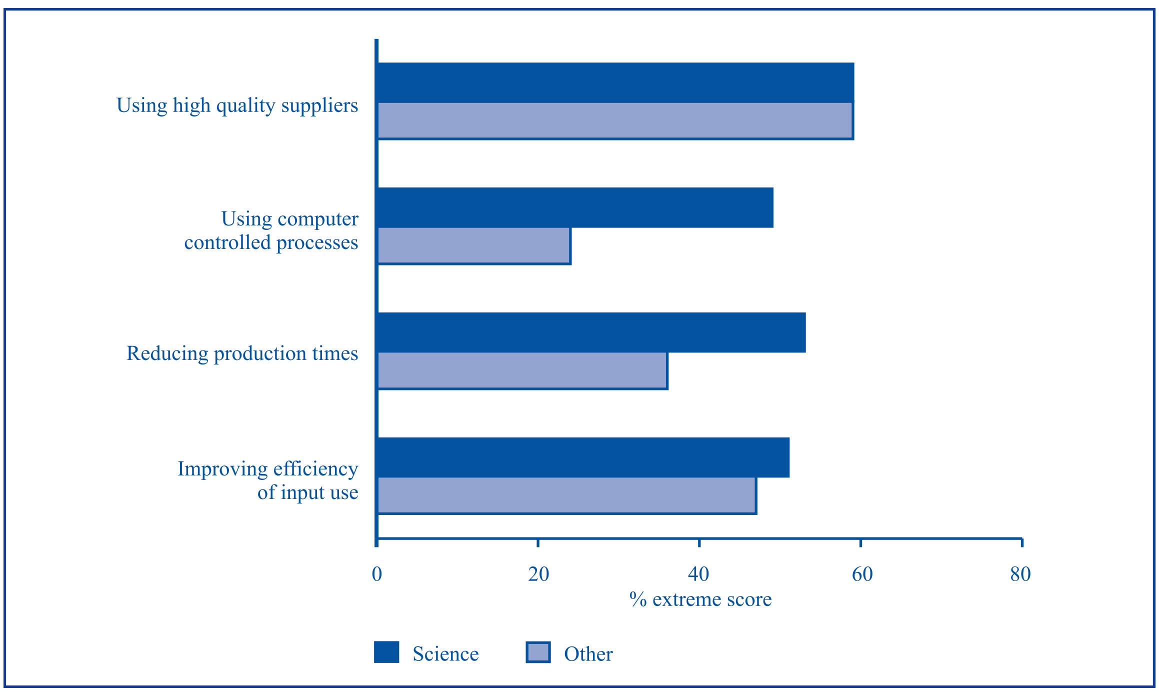


Figure 8
Importance of Production Strategies



New firms in science-based industries also give significantly more emphasis to R&D capabilities (Figure 7). Since most R&D is devoted to product development, this accords with the greater emphasis that science-based firms give to new product introduction and customization in order to reduce the problems of customer uncertainty.

Finally, new firms in science-based industries are significantly more likely to emphasize the need to protect their new products with intellectual property rights. About one-third of science innovators make use of intellectual property rights, while only 10% of the other group do so. Baldwin (1997) has shown that firms tend to use these property rights when their innovation is more novel. Therefore, new firms in science-based industries tend to produce more novel innovations.

Technology and Production Processes

New firms in science-based industries face considerably greater risk that their technology will become obsolete than firms elsewhere. In response, new firms in the science-based sector place much greater emphasis on the development of technology. There is less difference between the emphasis both groups place on purchasing new technology from others. The latter is an activity to which science-based firms give only about half the emphasis that they give to developing new technology (Figure 7).

Mastering technology is only one of the skills that is required for firms that face an uncertain production environment. Firms must also worry about input use, the quality of suppliers, reducing costs by cutting production time, and the incorporation of new computer processes (Figure 8). In keeping with the greater uncertainty associated with the production environment in the science-based sector, new firms in this sector are significantly more likely to focus on using computer controlled processes—probably because it is so closely associated with the advanced manufacturing technologies that are being introduced (Baldwin and Sabourin, 1995). New firms in science-based industries also place significantly greater emphasis on reducing production times—one of the impacts of the new advanced manufacturing technologies (Baldwin, Sabourin and Rafiquzzaman, 1996). There is little difference between the two groups in the extent to which they are improving the efficiency of input use or using high quality suppliers (Figure 8).

Marketing

New firms in science-based industries are more likely to rely on a small number of customers. This difference in the market means that retaining these customers is more important to these firms.

To accomplish this, new firms in science-based industries are significantly more likely to focus on satisfying existing customers (Figure 9). But they also face greater uncertainty from shifting consumer demand and greater reliance on a small number of customers. Uncertainty due to concentration of the customer base can be alleviated with diversification of that base. New firms in science-based industries do so in two ways. First, they focus

FIGURE 9
The Importance of Marketing Strategies

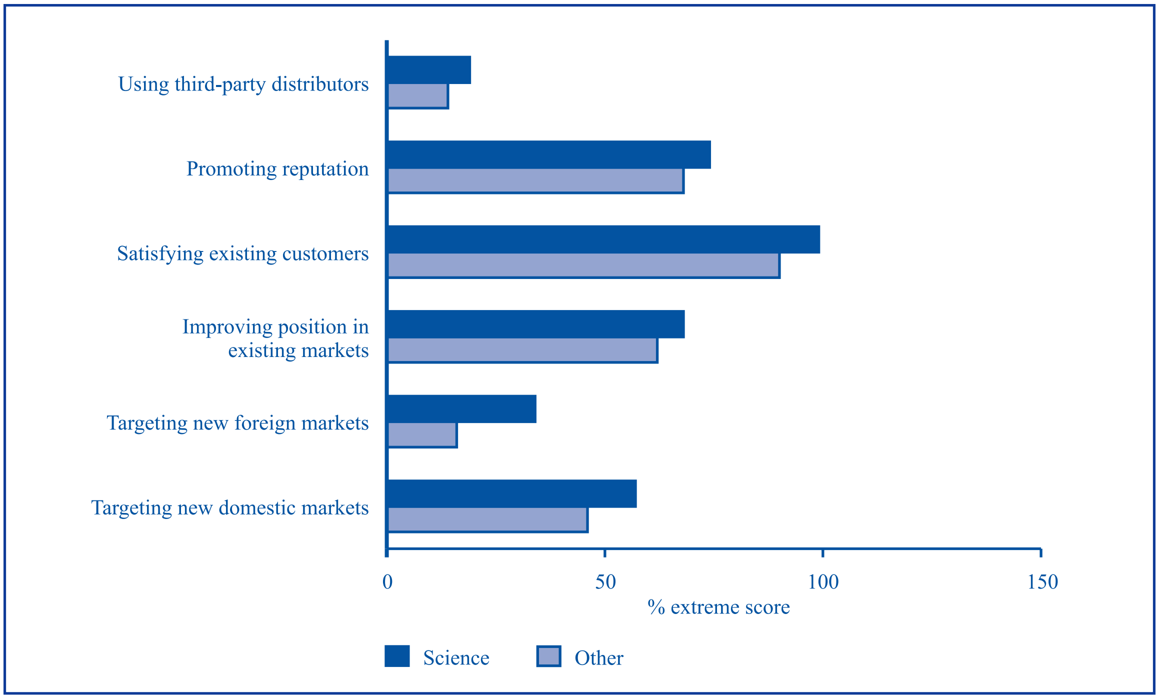
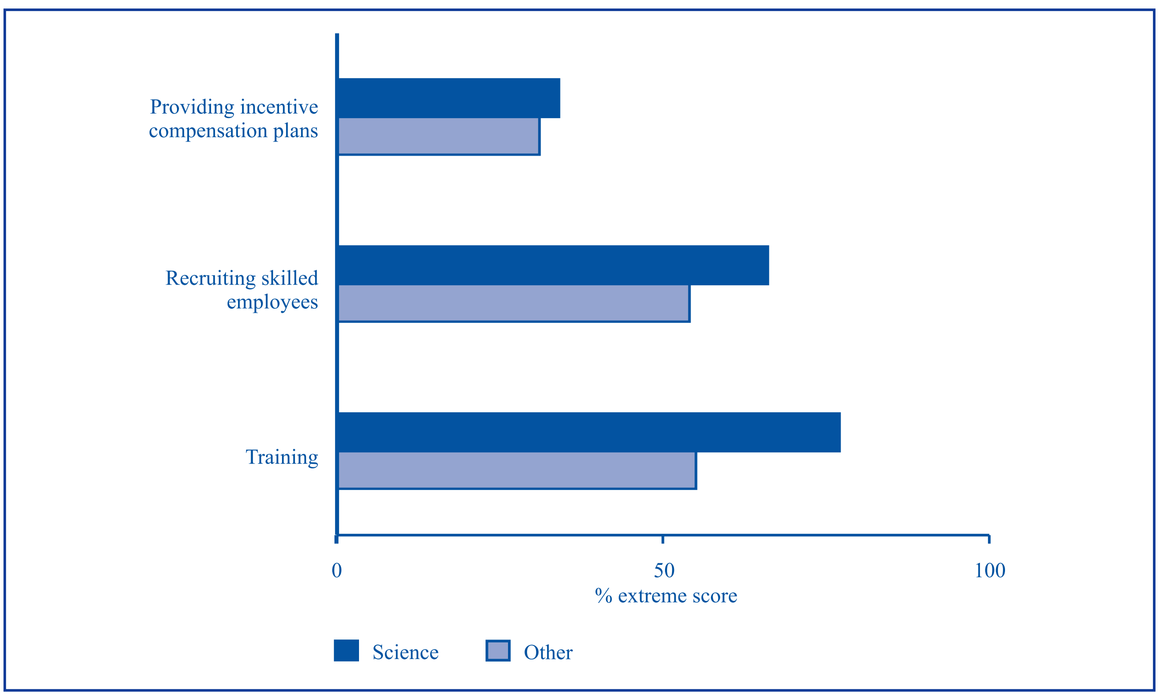


FIGURE 10
The Importance of Human Resource Strategies



more effort on expanding their sales in existing markets. Second, they give significantly greater focus to both new domestic and new foreign markets. The difference in the emphasis given to foreign markets is highly significant (Figure 9).

New firms in the science-based sector are rewarded for their marketing efforts outside the country. Some 36% of firms in this sector export outside Canada while only 11% of firms in other industries do so. Moreover, if they export, a larger percentage of sales come from exports—40% on average for firms in the science-based sector compared to only 25% of firms in other sectors.

Human Resources

Innovation activities and technological development require a skilled labour force. Baldwin and Johnson (1996a) demonstrate that the stress given to human resources in growing small- and medium-sized firms is higher in more innovative firms. Baldwin, Gray and Johnson (1995) find that firms that use advanced technologies are more likely to be training their workers in order to develop the skills necessary to operate the new technologies.

Since new firms in the science-based sector are both more likely to be introducing new innovations and to be placing more emphasis on new technologies, they might be expected to place greater stress on acquiring and developing the human capital that is an essential complement to both these strategies. This is the case. New firms in the science-based sector give significantly more emphasis to recruiting skilled employees than firms in other sectors. They also placed a significantly greater emphasis on training strategies. Concomitantly, a significantly larger percentage of these firms actually train their employees (Figure 10).

Financing

Financial planning and control are often regarded as serious problems for small firms, particularly those seeking to grow.[15] Financial concerns are likely to be even more serious in science-based industries for several reasons. First, firms in these industries are generally investing in 'soft' or 'knowledge' assets, such as R&D that are difficult to assign a value to, because the outcome of the investment is uncertain. Hence, it has been found that firms in 'knowledge-based' industries rely more heavily on less risk-averse equity capital (Johnson, Baldwin and Hinchley, 1997). Second, the competitive environment faced by these firms is riskier—especially in terms of uncertainties that arise from the loss of dominant customers and rapid technological change.

Despite these arguments that suggest financing problems would be given greater attention in the science-based sector, new firms located therein give less emphasis to all three areas of financial management—finding and maintaining capital, financial management, and flexibility in meeting unforeseen circumstances. The difference is statistically significant for the category 'finding and maintaining capital' (Figure 11).

[15] For a discussion of difficulties that small firms experience with regards to financial management and how they contribute to bankruptcy, see Baldwin et al. (1997).

Figure 11
The Importance of Financing Strategies

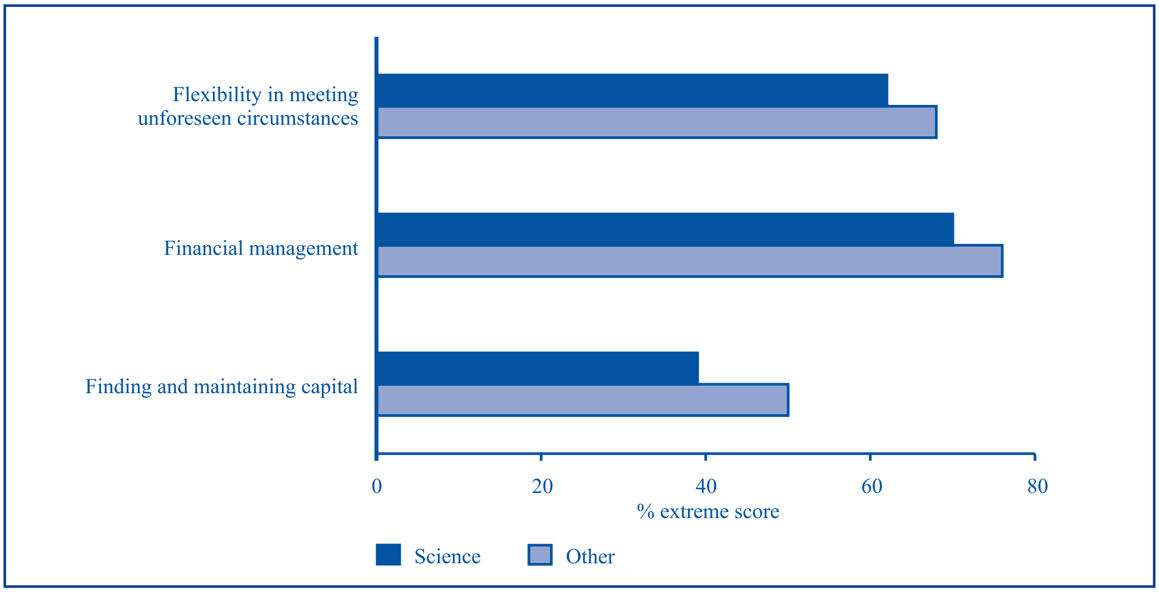
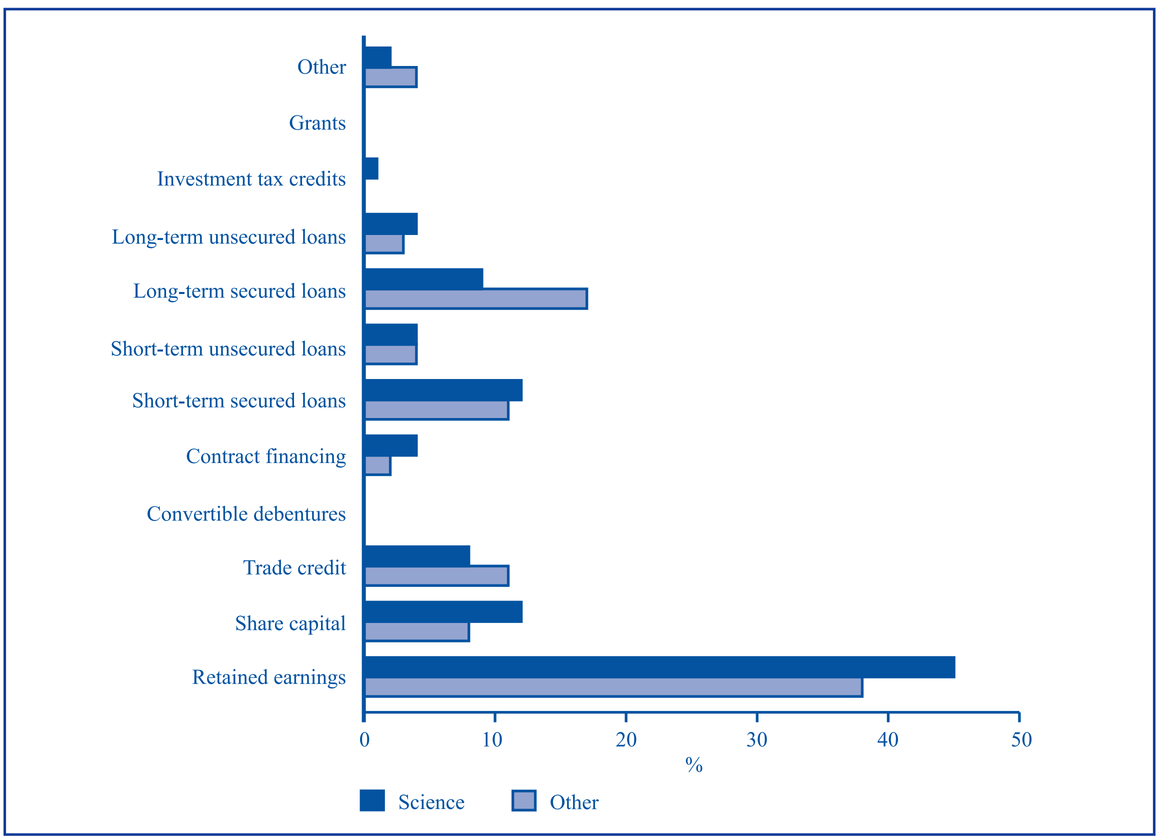


Figure 12
Breakdown of Financing



This finding may be due to the fact that the demands that are placed on new firms in science-based industries are sufficiently intense that the survivors must have substantial internal financial resources to survive. This may reduce their interest in developing the expertise to seek and acquire external financial resources. Firms in this sector develop and survive by focusing on their own internal funds and this may lead them to pay less attention to capital markets in general.

The absence of special attention that is given by new firms in the science-based sector to financing, relative to new firms in other industries, is also evident in their planning activity. There is little difference in the extent to which new firms in science-based industries and elsewhere have a financial plan (21% and 19%, respectively).[16] However, the contents and contributors to the plan differ. New firms in other industries are much more likely to include historical financial data (88%) than firms in science-based industries (67%).[17] This result is consistent with the tendency for other firms to utilize more traditional financial measures to assess their performance. It is also consistent with the finding that change (with regard to production technology and the introduction of new products) is more rapid in the science-based sector, perhaps reducing the relevance of previous data.

New firms in science-based industries that possess a financial plan are significantly more likely to have their plan reviewed by a board with outside directors and less likely to look to an independent certified financial advisor.[18] This indicates that networking with outside experts via the control and oversight structure is more important in science-based industries.

Slightly more new firms in science-based industries do not update the various components (income statement, balance sheet, cash flow statement, and capital expenditure statement) of the financial plan but these differences are not large.[19] Of those that do update their financial plan, science-based firms are more likely to do so on a more frequent basis than just annually for both cash flow and capital expenditure—which probably reflects the greater problem that they face with changing consumer tastes and technological progress.

Financial Structure [20]

New firms in science-based industries are significantly more likely to derive their financing from retained earnings (Figure 12). Share capital is also more important in the science-based sector—though the differences are not statistically significant. Some 57% of total financing come from both retained earnings and share capital in science-based industries as opposed to only 46% in other firms. About the same percentage (15%) comes from short-term secured and unsecured loans in both sectors. But firms in science-based industries average only 13% of total financing in the way of long-term loans while firms elsewhere receive some 20% from this source. Trade credit is also less important but contract financing is more important for science-based firms.

[16] See question H1 of the questionnaire.
[17] See question H2 of the questionnaire.
[18] See question H3 of the questionnaire.
[19] See question H4 of the questionnaire.
[20] See questions H5 and H6 of the questionnaire.

Figure 13
Sources of Funds

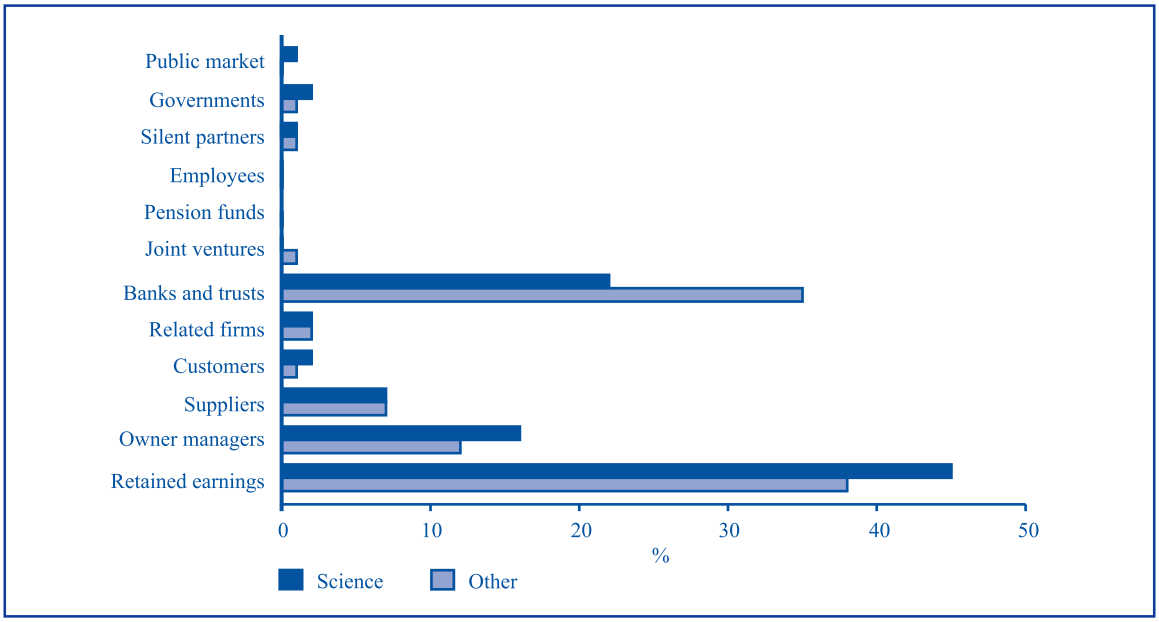
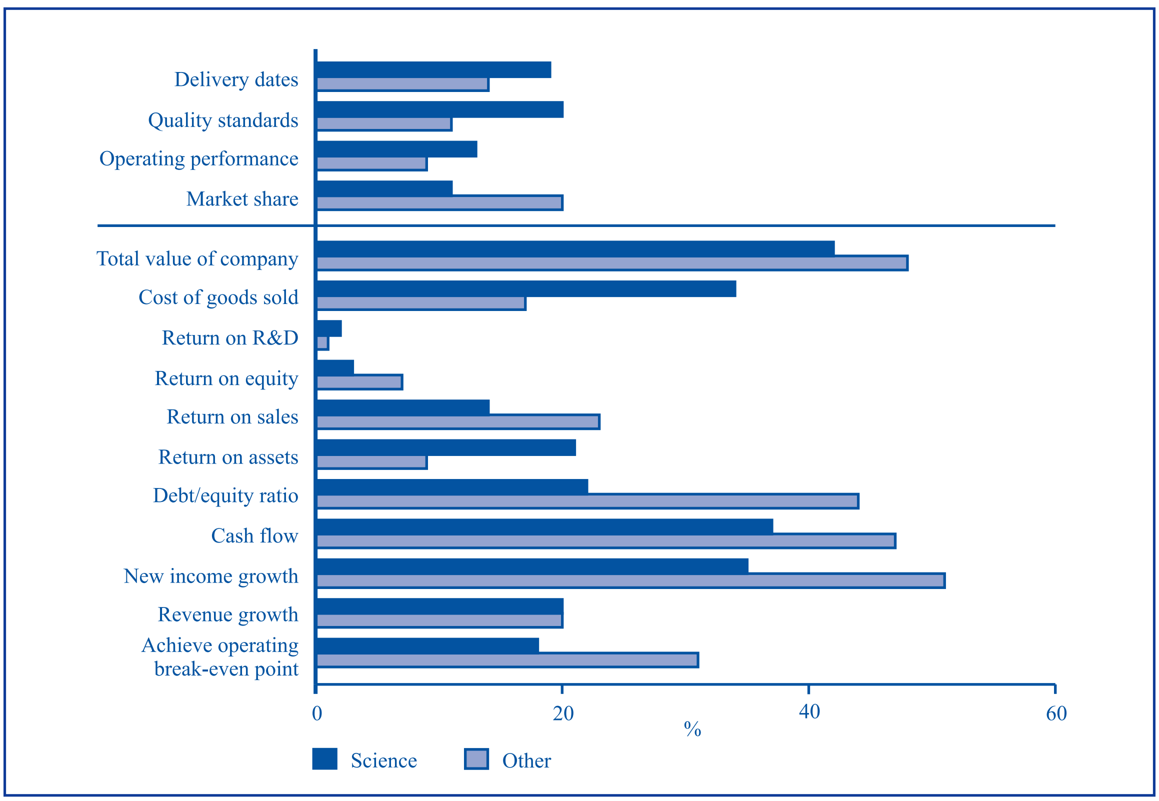


Figure 14
Performance Conditions



These differences are to some extent mirrored in the importance of the different sources of financing (Figure 13). Retained earnings and owner managers supply a significantly greater percentage of funds to science-based than to other industries (61% and 50%, respectively). It is of interest to note that owner managers supply less than the proportion of finance that comes from share capital in science-based industries thereby suggesting outside participation. The opposite is the case for other industries, thereby suggesting that owners in the latter group of industries supply capital in the form of loans of various types rather than through shares.

Finally, new firms in science-based industries are much less likely than other firms to access funds from banks and trust companies—22% and 35%, respectively. These differences are both large and statistically significant.

Conditions Imposed by Lenders

The percentage of new firms in the two groups that have performance conditions attached by lenders is much the same. New firms in science-based industries are more likely to have conditions imposed in the non-financial area than the financial area (Figure 14). Indeed, for all but the return-on-assets ratio, the percentage of firms in the other group that have a particular financial measure like the debt/equity ratio attached as a condition of lending is greater than in the science-based sector. On the other hand, the percentage of firms in the science-based sector having to meet quality standards, delivery dates, or operating performance measures, like down time, is greater than in other industries.

Matching of Use and Source of Funds

The activities of new firms and their financial structure are closely related. Activities determine risk and the financial structure must adapt to that risk. Riskier firms generally rely more on capital that is committed on a longer term to the firm (Johnson, Baldwin and Hinchley, 1997). Firms in science-based industries are, therefore, more likely to depend more on certain forms of long-term capital.

Despite this, it is of interest to determine whether firms in the two sectors are more inclined to use specific sources of funds for specific types of investments. We know, for example, that R&D is relatively risky and is likely to be funded out of internally generated funds. Here we ask whether it is the case that R&D is more likely to be funded out of this source in science-based industries and whether other investments like machinery and equipment are also more likely to be funded out of retained earnings. Finding either implies that R&D activities in science-based industries are riskier than elsewhere or that firms in these industries are even more dependent on internal sources of funds than elsewhere because of other problems—inertia on the part of the firm, asymmetric information that affects lending conditions across many different instruments, or market imperfections that leads the firm to substitute away from external capital.

Figure 15
Retained Earnings Use

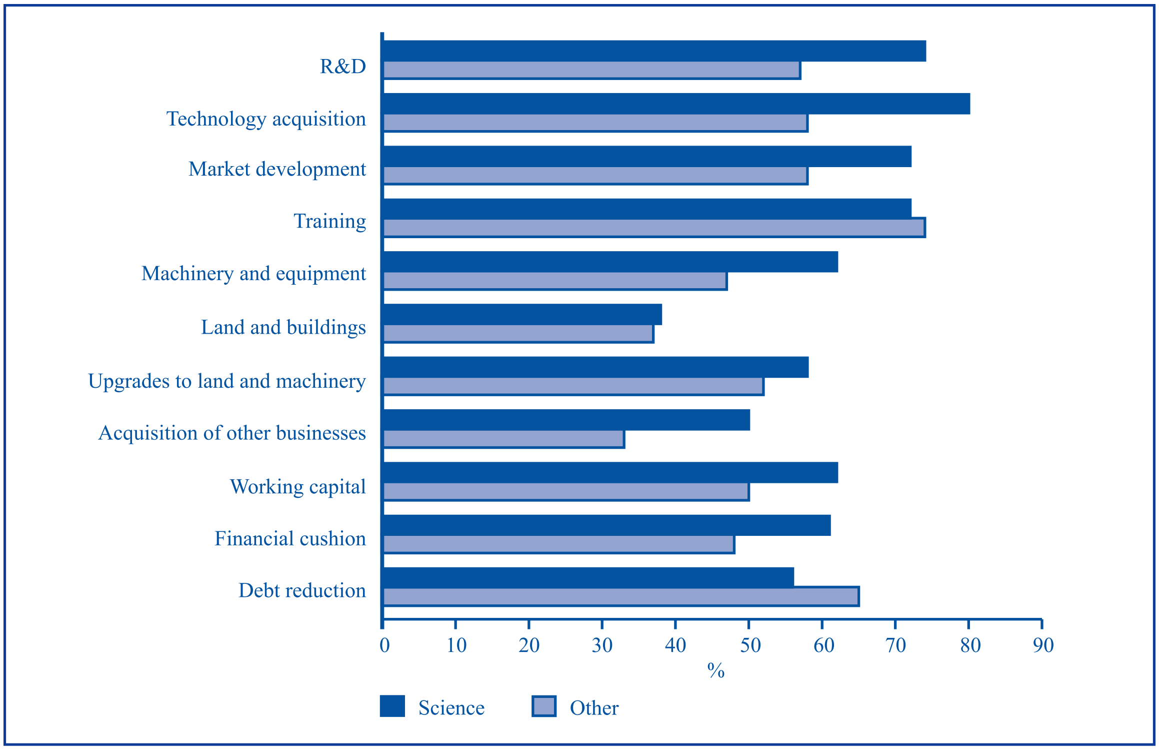
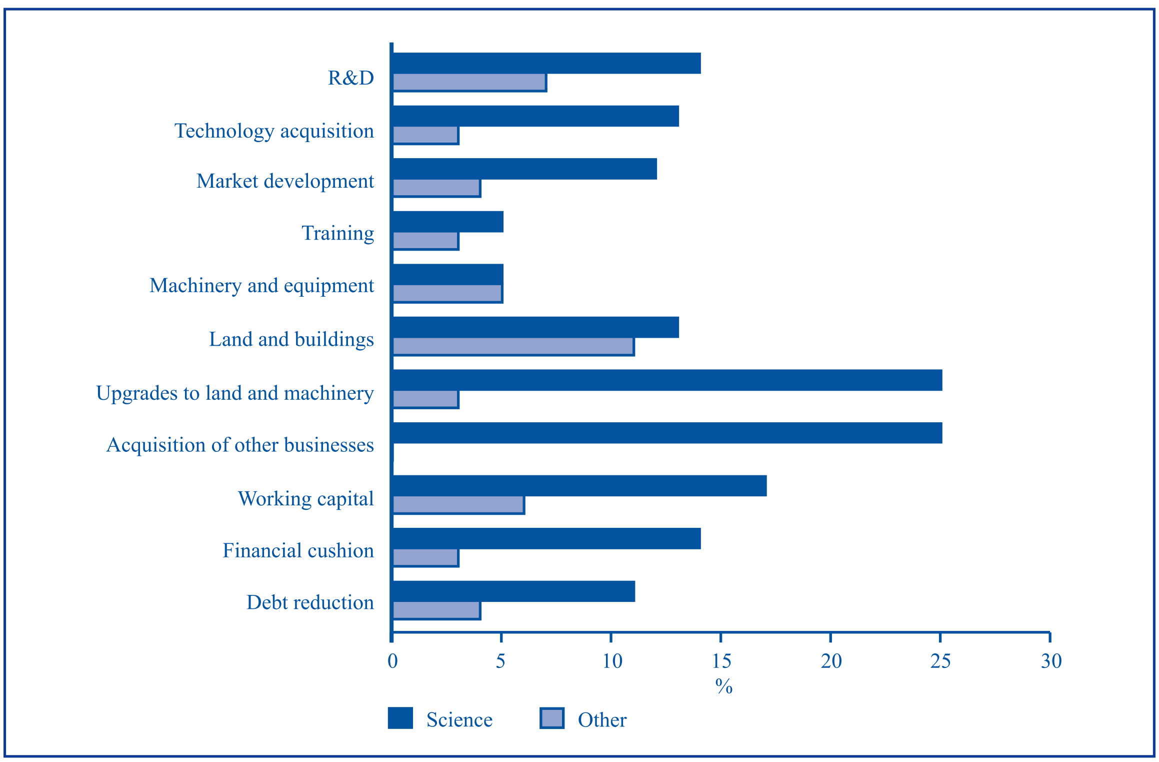


Figure 16
Share Capital Use



To investigate this issue, we calculate the percentage of firms making a specific investment (i.e., R&D, machinery and equipment) that indicate they utilize a specific source of funds (i.e., retained earnings loans). The percentages for retained earnings are reported in Figure 15; for share capital in Figure 16; for short-term secured loans in Figure 17; and for long-term secured loans in Figure 18.

There are similarities between the two groups of industries in that retained earnings are a source of funding for all activities (Figure 15).[21] Short- and long-term debt are most frequently utilized for expenditures related to machinery & equipment, land & buildings (Figures 17 and 18). Working capital and a financial cushion for uncertainties is often provided for by a line of credit.

Nevertheless, there are several important distinctions between firms in science-based industries and firms in other industries. In science-based industries, retained earnings are relatively more important (where importance is defined as the proportion of firms using this source for an activity) for investments in 'knowledge assets', such as R&D, technology acquisition, market development and training (Figure 15). The differences between science-based and other industries are particularly marked for R&D and technology acquisition (Table 1, column 1). It is also the case that firms in science-based industries use share capital more for the acquisition of knowledge assets (Figure 16 and Table 1, column 2).

It is noteworthy that firms in science-based industries are relatively more likely to focus on retained earnings for knowledge-based assets than for the purchase of machinery and equipment but to use share capital relatively more for land and buildings, upgrades to land and machinery and for the acquisition of other firms. They also use share capital more for this purpose than do firms in other industries (Table 1, column 2). Other firms will use retained earnings to acquire machinery and equipment upgrades and acquisitions more than they do to develop knowledge assets.

When it comes to financing investments in machinery and equipment, land and buildings, or upgrades to existing land, machinery and equipment, science-based firms are generally more likely to rely on retained earnings (Figure 15) and less likely to rely on short-term or long-term secured loans (Figures 17 and 18 respectively).

The differences between science-based and other industries are summarized in Table 1, with shading being used to highlight significant differences.

It is noteworthy that for both retained earnings and share capital, there are positive differences between firms in science-based and other industries for almost all uses of funds—though the largest and most significant differences are in the knowledge-based uses. Similarly, there are negative differences in the majority of uses for short- and long-term secured loans. The largest differences are in the use of short-term secured loans. Differences still exist but are somewhat smaller for long-term secured loans.

[21] See answers to question H8 of the questionnaire.

FIGURE 17

Use of Short-term Secured Loans

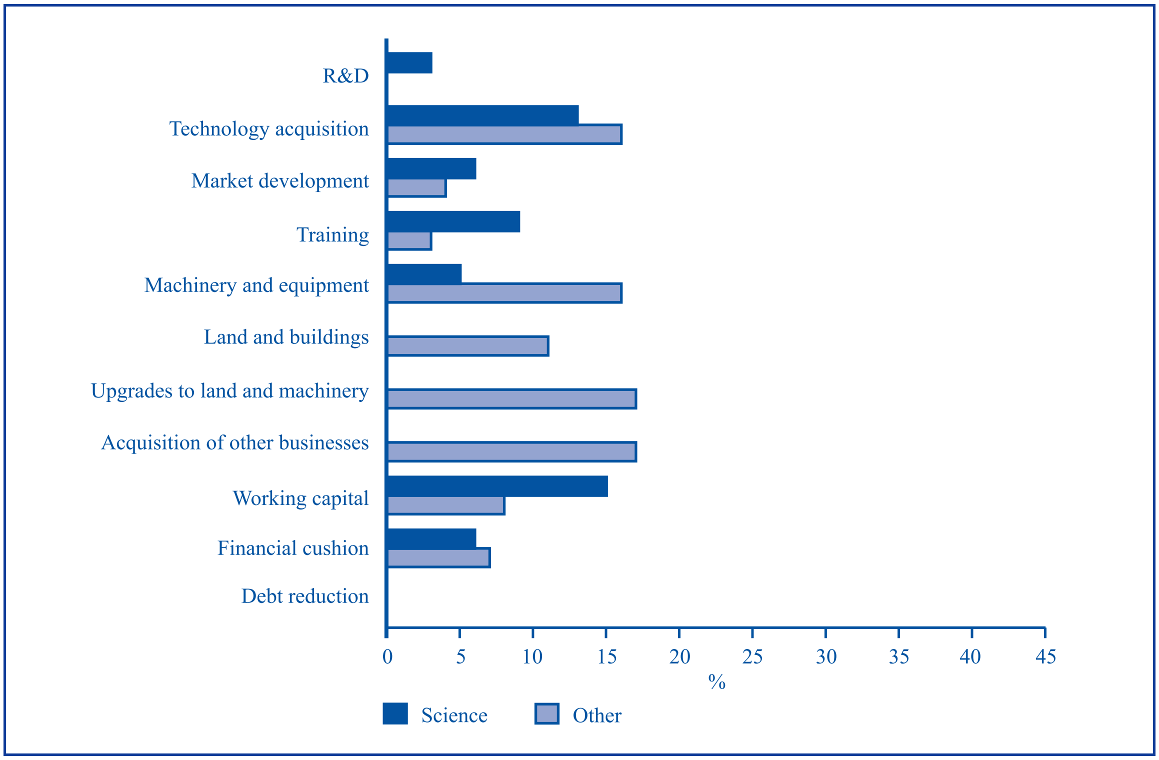


FIGURE 18

Use of Long-term Secured Loans

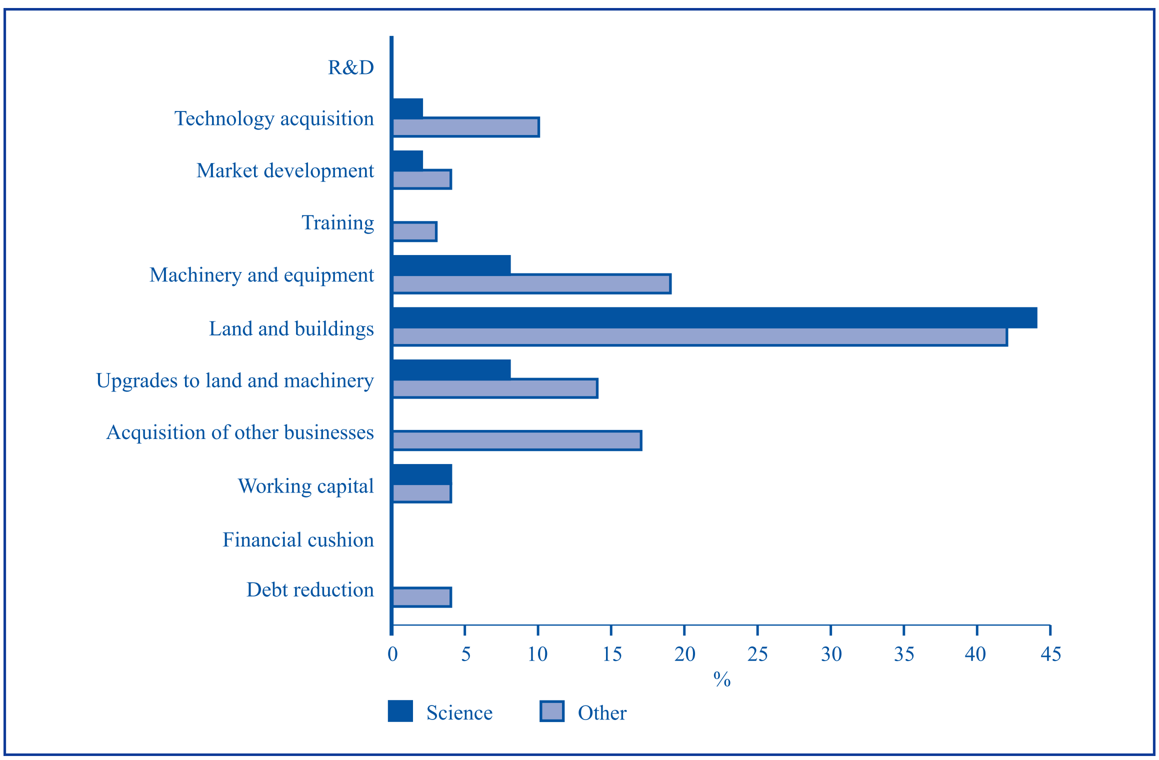
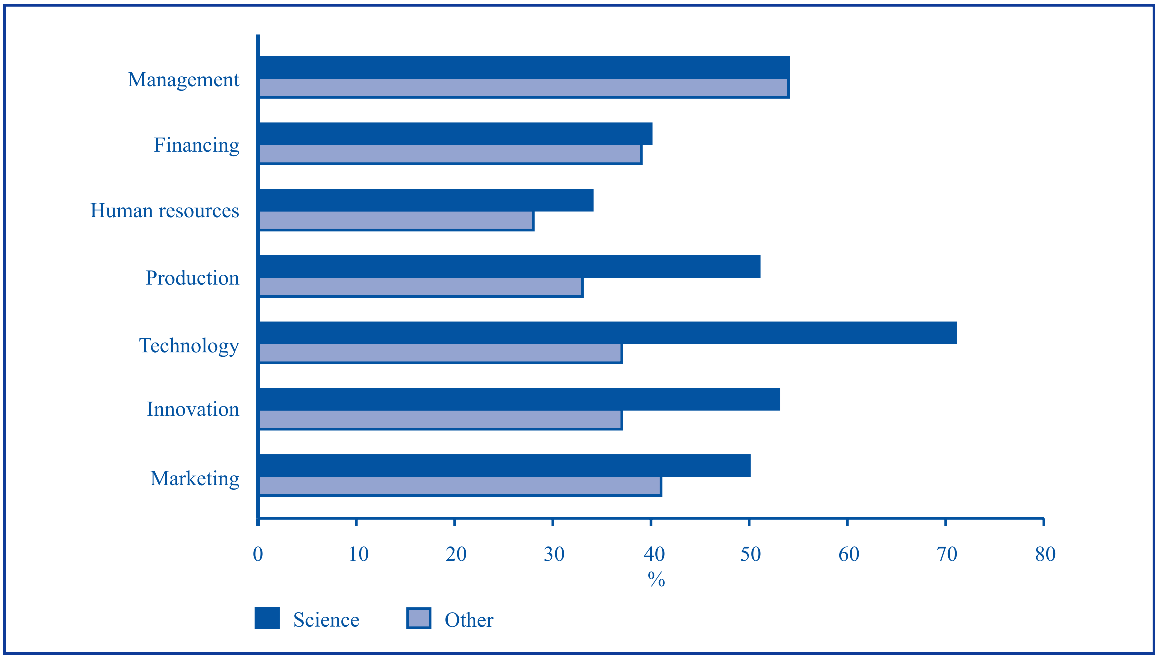


Figure 19

Changes in Capabilities



In summary, firms in science-based industries generally are more likely to rely on retained earnings as a source of funds for all of their investments. The differences are highly significant for knowledge-based investments in R&D, technological acquisition and market development. But this source of funds is also used more frequently in other areas—though the difference is not as significant. It is also the case that these firms tend to make less use of secured loans across all categories—even those categories like machinery where collateral should provide less of a problem. It is, therefore, the case that some but not all of the greater reliance on internally generated funds in science-based sectors stems from their greater emphasis on knowledge-based investments.

The Evolution in Firm Capabilities

New firms pass through different stages and as they do, the need for different competencies may change. In the initial stages of growth, the focus may be more on technology as innovation drives the firm. As companies become larger, competencies that are required to run a larger firm may become more important. For instance, as the organization becomes more complex, the emphasis on human resources may have to increase or missing gaps in financing may have to be addressed.[22]

The new entrants reported the areas in which their capabilities had changed in the five years prior to the survey. Differences in firms' capabilities in the recent past broadly confirm the special emphasis that firms in science-based industries place on the technological areas. New firms in science-based industries are more likely to report that their capabilities had

[22] Wynarczyk et al. (1993) find that high growth firms in the UK increase the importance given to financing as they mature.

increased in a broad range of areas—production, innovation, technological capabilities, marketing and human resources (Figure 19). The largest and most statistically significant differences between new firms in science-based and ‘other’ industries occur in innovation, technology and production. It is noteworthy that despite the relatively greater emphasis generally given to most capabilities, here too financing did not receive special attention.

Table 1. Sign Difference of Usage Rates of Types of Funds by Category of Use—Science versus Other

Use of funds	Types of Funds: Retained earnings	Share capital	Trade credit	Contract financing	Line of credit	Short-term secured loans	Short-term unsecured loans	Long-term secured loans	Long-term unsecured loans	Convert-ible deben-tures	Invest-ment tax credits	Grants
R&D	+*	+*	+*	+*	-	+	-	-	+*		+*	+
Technology acquisition	+*	+*	+	-	-	-	+*	-*	-		+*	+
Market development	+	+*	+	-	-	+	-	-*	-*		+*	+*
Training	-	+	+	+*	-	+	+	-*	-	-	+*	+*
Machinery and equipment	+	+	+	-*	+	-*	-*	-*	+		+*	+
Land and buildings	+	+	+	-*	+	-*		+	+*		+*	+
Upgrades to land and machinery	+	+*	-		+	-*	+*	-	+			+
Acquisition of other businesses	+	+	-		-*	-	+*	-*	+			
Working capital	+	+*	-	-	-	+	+	-	-		+*	+*
Financial cushion	+	+*	-		-	-	-	-*	-	+	+*	+*
Debt reduction	-	+*	-		+*	-	+	-*	+	+*	+*	+
Pluses	9	11	6	2	4	4	6	1	6	2	9	10
Minuses	2	0	5	5	7	7	4	10	5	1	0	0

Note: * indicates a significant difference at the 10% level.

Conclusion

This paper has investigated whether new firms in science-based industries differ from those in other industries. In particular, it asks what these differences tell us about the financing strategies and the problems faced by new firms in science-based industries.

It finds that there are fewer differences in the environment that these firms face and in their objectives (the *what*) than in the methods that they use to accomplish their goals (the *how*).

Both groups face many of the same factors that create a highly competitive environment. They face about the same number of other firms as competitors and they both evaluate the threat of entry as high. Slightly more new firms in science-based industries are in the earlier phase of the product life cycle—but the majority of firms in each group are in the more mature phase. They both give about equal stress to quality, customer service, or flexibility. Firms in science-based industries do place a higher emphasis on strategies that are more closely related to innovation like the introduction of new products or the customization of products and less to price competition.

The primary difference in the competitive environment of the two groups lies in the greater risk of firms in science-based industries that stems from uncertainty about consumer demand and the vulnerability that arises because they are reliant on a smaller number of customers. Because of this, suppliers and customers in science-based industries are more tightly linked via an interdependent web; in other industries, customers and producers are not as closely connected and they can form new commercial partnerships more easily. While firms in the latter group interact with a wider range of agents, their dependence on any one of those agents is more limited. Rapid changes in technology are also more prevalent in the science-based sector.

Differences in substitutability are associated with differences in competitive strategies. New firms outside the science-based sector give a greater emphasis to price since it has such an obvious effect on the tendency of customers to switch from one supplier to another. On the other hand, new firms in the science-based sector focus more on the frequency of new product introduction, and customization in order to minimize customer loss.

This difference is manifested in large and significant differences between the two groups in their type of innovation system. New firms in science-based industries are more likely to innovate. The primary differences here are on the product side. The science-based industries specialize in product innovation that is then incorporated as process innovations or intermediary product innovations elsewhere (Robson, Townsend and Pavitt, 1988). Differences in the rate of product innovation are reflected in differences in the emphasis that is given to R&D—one of the more important inputs into the product innovation process. New firms in science-based industries are more likely to focus on patents to protect their intellectual property, which indicates that there is a difference in the novelty of the innovations that are produced in the two sectors.

Differences in the rate of obsolescence of technology in the two sectors are translated into differences in production strategies. New firms in science-based industries give more emphasis to developing new technology. They are also more likely to focus on computer controlled processes—part of advanced technologies—and reducing production times.

New firms in science-based industries also focus more attention on the human resource component of the innovation process. This is a key component that is sometimes ignored by those who focus exclusively on the importance of research and development. Previously, we emphasized that innovation is closely connected to the innovation strategy of small- and medium-sized firms (Baldwin and Johnson, 1996a). The evidence presented herein confirms that this finding also applies to entrants. New firms in science-based industries pay considerably more attention to human-resource strategies. They are also more likely to train their employees.

Emerging firms in science-based industries face two major problems in their environment—they are more likely to depend on fewer customers and the demand of these customers is highly uncertain. In response, new science-based firms adopt an aggressive innovative marketing strategy. They place greater stress on satisfying existing customers because of the consequences of volatility in situations where one firm relies heavily on another. But science-based firms also try to reduce their reliance on a small number of customers by placing more emphasis on customer diversification. This is done by targeting both new domestic and new foreign markets. They are successful in this regard. They are more likely to be exporters and, if so, to derive a larger percentage of their sales from exports.

Previous research (Baldwin and Johnson, 1996b) has demonstrated that small- and medium-sized innovative firms place greater stress on developing their competencies in a wide range of areas, relative to other non-innovative firms. The findings presented here indicate that this result is true for new firms as well. New firms in science-based industries differ from their counterparts in other industries across a large number of dimensions. New firms in science-based industries place greater emphasis on enhancing their competencies in the areas of technology, human resources, production and marketing. They have also been increasing their capabilities in each of these areas more than have firms in other sectors—with the greatest differences being in the areas of innovation, technology and production. Innovation and R&D—common in the science-based industries—also require superior skills to acquire new technologies, retrain the workforce in order to produce new products, and to market new products.

While new firms in science-based industries pay more attention to a wide range of areas, there is one anomaly. The exception lies in the area of finance. While new firms in science-based industries pay more attention to innovation, training and aggressive marketing, they are less likely to stress financing issues than are firms elsewhere. Indeed, they are significantly less likely to worry about finding and maintaining capital than firms in other industries. This is ironic since so much attention has been paid to the problems of financing of high-tech business. New firms generally lack the history and reputation that financiers rely on to evaluate firms. Moreover, the very nature of the activities in the science-based sector—specifically related to research and development—are inherently risky. Indeed, their reluctance to monitor financial criteria, in favour of operating criteria suggests that valuation both for themselves and outsiders, from a strictly financial standpoint, is difficult. At the same time, this report has shown that firms in science-based industries are vulnerable to changes in their customers, suppliers and production technology. Together, these risks make it more difficult for these firms to find financing that affords them the flexibility they require. Despite their potentially greater problems with financing, the data on the existence of financial plans does not suggest that firms in science-based industries engage in more financial planning. There is little difference in the extent to which firms in the two groups have financial plans.

Problems that new firms have with financing then may be the result of their not paying due attention to this aspect of their business. Other evidence supports this explanation. Wynarczyk et al. (1993) reports that the one area in which young firms have to add expertise in their early years if they are to be successful is in the area of finance.

The financial structure differs substantially between the two groups. Equity capital—in the form of either retained earnings or share capital—is more important in the science-based sector. Conversely, long-term secured loans account for a larger proportion of total capital in other industries. Not surprisingly then, retained earnings and funding from owner managers are more important in the science-based sector, whereas banks and trust companies are more important in other industries.

Perhaps the difference in emphasis on financial matters, especially with regards to finding capital, arises because science-based industries are more likely to use retained earnings and they obtain fewer long-term loans. Banks provide less of the total capital to science-based firms. The fact that firms in science-based industries pay less attention to finding capital may simply be a product of the fact that less internal financial expertise is developed when outside sources of funds are accessed on a regular basis.

What causes the difference in financial structure? The greater reliance on internal funds and share capital may be due to the increased risk of lending to science-based firms. Our information on competitive environment suggests that these firms face a slightly higher risk as a result of greater technological obsolescence, and higher levels of unpredictability of consumer demand. But more suggestive of higher risks are the differences in the conditions that lenders attach to financing. These differences confirm the difficulty that financial markets have in evaluating and monitoring firms in science-based industries. These firms face conditions that are more likely to be related to operations than to financial ratios. The latter are more difficult to interpret in science-based industries for a number of reasons. First, it is more difficult to evaluate knowledge assets related to research and development expenditure, training or market development. Second, some of the output of the firm will consist of unpriced assets such as software under development and, therefore, total assets will be undervalued in many science-based companies.

The existence of financing difficulties accords with the greater reliance of new firms on internal sources of financing for knowledge-based assets. Science-based firms are not only more likely to require financing for soft assets that arise from R&D expenditures, training and market development, but they are also more likely to raise funds for these purposes from retained earnings. There is, therefore, a close connection between success and profitability in science-based industries.[23] Internal sources of funds are more critical to the key expenditures on research and development, technology acquisition and training that lead to growth in science-based industries than elsewhere. Future success requires internal funds, which in turn tend to be generated by past success.

The difference in the type of loans given to firms in science-based industries is another sign that these firms face less certainty in their financial environment. Firms in science-based industries are less likely to use long-term secured loans for R&D, technology acquisition, market development and training but they are also less likely to use these forms of capital for machinery and equipment purchases. Thus, new firms in science-based industries not only have to rely on internal funds, which tend to be highly cyclical, but they apparently are considered to have particular difficulties even in areas where there should be more ‘hard’ collateral.

Finally, the evidence on the matching of use and sources of funds shows that only part of the difference in capital structure is related to the types of activities that the two groups of firms undertake. Firms in science-based industries may have more retained earnings because they do more R&D and this is financed primarily by using retained earnings; these firms also tend to be more likely to finance harder assets like machinery and equipment from retained earnings. They have less long-term loans not just because they have a lower proportion of their investment in machinery and equipment, which uses this as a prime source of financing—but they are less likely even when they invest in machinery and equipment to use this source. It would appear that differences in the environment that are related to risk, differences in the way these firms treat financial issues, or differences in the way financial markets assess risk, force firms in the science-based sector to rely more on risk-sensitive equity, as opposed to bank debt across a wide range of activities.

[23] See Nelson and Winter (1982)

Methodology

The data used to produce this report were collected in the *Survey of Operating and Financing Practices.* This section describes the frame and the sample of 'recently born' firms, how that sample was drawn, how the questionnaire was developed, the response rate to the survey, and the generation of the data.

The Frame and Sample

For the purposes of this study, 'recent' entrants were deemed to be firms born in the years 1983-86. Employing the Longitudinal Employment Analysis Program (LEAP) database[24], we found that 545,514 firms started up during the 1983 to 1986 period. Of those, 126,746 firms survived to 1993 and serve as a base frame for the group of start-ups that we refer to as 'emerging firms'; firms that emerge out of 'childhood' into their early teen years. There were 39,675 firms for which the financial information in both the year of birth and 1993 could be obtained and, thus, formed the final frame for this survey.[25]

From the frame of 39,675 firms, a sample of 3,991 firms was selected. The sample was stratified by four criteria to permit investigation of the profiles of different firm types. In summary, the sample was drawn from the following strata: size (in 1993), the growth in employment from birth to 1993, the knowledge-intensity of the industry (within the goods and service sectors) and the relative debt-to-asset ratio.

The Survey

Data collection was carried out in three stages. Initially, the firms were contacted by phone to determine who was running the business. Then the questionnaire was addressed and mailed directly to the person responsible for the day-to-day operations of the business. Finally, interviewers conducted telephone follow-ups for incomplete or non-responses. The majority of responses were obtained via these telephone interviews. The response rate to the survey was 80%, a very high response rate by both industry and Statistics Canada standards.

Each of the questions also had a very high response rate (between 78% and 100%). In cases in which a manager responded to all but a few questions, we imputed the missing responses. Imputing data involves estimating the true response for a firm on a particular question. To

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[24] See Statistics Canada (1988) for a description of the database.

[25] This sample includes only the commercial sector—that is government, education and health are not part of the universe being examined.

do so, we use information on the size, debt-to-asset level, industry, and growth of the firm, as well as responses to other survey questions to infer the missing response.

Imputation of missing data was performed since failure to impute missing responses is equivalent to assuming that the missing responses are no different from those of the average member of the population. However, missing responses occur more often for smaller and declining firms. These are often the types of firms that are less likely to value many of the strategies or engage in many of the activities investigated in the survey. Consequently, the true responses for the missing observations are not likely to be similar to those of the average firm, and assuming this is the case introduces an upward bias to estimates based on unimputed data.

In order to reflect differences in the proportion of the population that was sampled in each stratum, weights were calculated by dividing the population count at the strata level by the sample count at the strata level. The population estimates were then calculated by applying the associated weight to the sample responses.

Statistics Canada

Survey of Operating and Financing Practices

SCIENCE-BASED	OTHER

This document should be completed by the person responsible for the daily operations of the firm

Section A: About the Manager

A1 Length of time the manager has worked for the firm

SCIENCE-BASED	OTHER	
5	5	% worked for 0 to 2 years
12	4	% worked for 3 to 5 years
16	7	% worked for 6 to 9 years
68	85	% worked for more than 10 years

A2 Length of time the manager has worked in the industry

SCIENCE-BASED	OTHER	
4	3	% worked for 0 to 2 years
6	3	% worked for 3 to 5 years
15	3	% worked for 6 to 9 years
76	91	% worked for more than 10 years

A3 Length of time the manager has worked as a manager

SCIENCE-BASED	OTHER	
5	4	% worked as a manager for 0 to 2 years
13	3	% worked as a manager for 3 to 5 years
9	8	% worked as a manager for 6 to 9 years
73	85	% worked as a manager for more than 10 years

A4

SCIENCE-BASED	OTHER	
72	80	% of firms have at least one manager with ownership in the firm

A5 Managers acquired ownership by:

SCIENCE-BASED	OTHER	
79	69	% started the business themselves
1	10	% inherited or purchased it from a family member
8	15	% purchased it from a non-family member
6	5	% started it as a team or a joint venture
4	4	% purchased or acquired shares as an employee
7	3	% acquired it through other methods

Note: Totals may sum to greater than 100 because multiple methods are possible

SCIENCE-BASED

A6 The length of time the firm has been under the present ownership contract

- 2 % of firms have been under the same ownership for 0 to 2 years
- 2 % of firms have been under the same ownership for 3 to 5 years
- 10 % of firms have been under the same ownership for 6 to 9 years
- 86 % of firms have been under the same ownership for more than 10 years

A7 Management ownership of firm

- 84 % of firms reported that management owned more than 50% of the firm

Section B: Competitive Environment

B1 The number of competitors

- 8 % had no competitors
- 13 % had 1 to 4 competitors
- 37 % had 5 to 19 competitors
- 23 % had 20 to 99 competitors
- 19 % had more than 100 competitors

B2 The degree to which the respondents agree or disagree with the following statements about the industry in which they are located
(percentage distribution of firms):

	disagree 1	2	neutral 3	4	agree 5
Products quickly become obsolete	23	10	41	15	12
Production technology changes rapidly	6	5	28	25	36
Liquidation value of machinery and equipment is well below purchase cost	2	1	44	19	34
Consumer demand is easy to predict	35	23	27	14	1
Consumers can easily substitute among competing products	8	22	24	18	28
Competitors' actions are easy to predict	21	24	42	7	7
Competitors can easily substitute among suppliers	5	16	54	10	15
The arrival of new competitors is a constant threat	10	14	24	20	32

OTHER

A6 The length of time the firm has been under the present ownership contract

- 6 % of firms have been under the same ownership for 0 to 2 years
- 4 % of firms have been under the same ownership for 3 to 5 years
- 8 % of firms have been under the same ownership for 6 to 9 years
- 83 % of firms have been under the same ownership for more than 10 years

A7 Management ownership of firm

- 88 % of firms reported that management owned more than 50% of the firm

Section B: Competitive Environment

B1 The number of competitors

- 10 % had no competitors
- 12 % had 1 to 4 competitors
- 33 % had 5 to 19 competitors
- 19 % had 20 to 99 competitors
- 26 % had more than 100 competitors

B2 The degree to which the respondents agree or disagree with the following statements about the industry in which they are located
(percentage distribution of firms):

	disagree 1	2	neutral 3	4	agree 5
Products quickly become obsolete	23	19	35	13	11
Production technology changes rapidly	11	10	35	22	22
Liquidation value of machinery and equipment is well below purchase cost	7	7	28	14	45
Consumer demand is easy to predict	24	18	32	13	14
Consumers can easily substitute among competing products	8	8	24	21	39
Competitors' actions are easy to predict	23	17	35	13	11
Competitors can easily substitute among suppliers	8	8	31	15	38
The arrival of new competitors is a constant threat	10	7	22	17	44

SCIENCE-BASED

B3 The intensity of competition in the industry of the respondent (percentage distribution of firms):

	Intensity of Competition: low 1	2	3	4	high 5	Does not apply
Price	6	14	16	18	41	5
Flexibility in responding to customer needs	2	6	30	22	28	11
Quality	1	6	36	25	31	0
Customer service	2	7	40	18	32	1
Customization of products	13	16	11	16	21	23
Offering a wide range of related products	14	7	18	14	20	26
Frequently introducing new and improved products	7	20	12	18	16	27

Section C: Competitive Strategies

C1 24 % of firms had a written business plan

C2 Business plan revision or update in the last 5 years

- 13 % updated their business plan more frequently than semi-annually
- 13 % updated their business plan semi-annually
- 51 % updated their business plan annually
- 11 % updated their business plan bi-annually
- 12 % updated their business plan less frequently than bi-annually
- 1 % never updated their business plan

C3 The criteria used to assess performance

Financial Measures

- 31 % used achievement of operating break-even point
- 61 % used revenue growth
- 62 % used net income growth
- 52 % used cash flow
- 16 % used debt/equity ratio
- 6 % used return on assets ratio
- 15 % used return on sales ratio
- 6 % used return on equity
- 6 % used return on R&D ratio

OTHER

B3 The intensity of competition in the industry of the respondent (percentage distribution of firms):

	Intensity of Competition: low 1	2	3	4	high 5	Does not apply
Price	5	2	16	19	54	4
Flexibility in responding to customer needs	2	5	31	24	33	6
Quality	3	6	28	26	33	4
Customer service	3	5	24	27	38	3
Customization of products	6	14	24	16	13	26
Offering a wide range of related products	6	9	21	19	24	21
Frequently introducing new and improved products	10	10	21	17	12	30

Section C: Competitive Strategies

C1 19 % of firms had a written business plan

C2 Business plan revision or update in the last 5 years

- 11 % updated their business plan more frequently than semi-annually
- 16 % updated their business plan semi-annually
- 56 % updated their business plan annually
- 2 % updated their business plan bi-annually
- 9 % updated their business plan less frequently than bi-annually
- 7 % never updated their business plan

C3 The criteria used to assess performance

Financial Measures

- 35 % used achievement of operating break-even point
- 53 % used revenue growth
- 58 % used net income growth
- 48 % used cash flow
- 25 % used debt/equity ratio
- 19 % used return on assets ratio
- 24 % used return on sales ratio
- 12 % used return on equity
- 4 % used return on R&D ratio

SCIENCE-BASED

C3 The criteria used to assess performance – *(continued)*

Financial Measures

27	% used cost of goods sold
28	% used total value of company
2	% used other financial criteria

Non-Financial Measures

27	% used market share
25	% used operating performance (down time etc.)
60	% used meeting quality standards
55	% used meeting delivery dates
4	% used other non-financial criteria

C4 Important factors to the *firm's* competitive strategy (percentage distribution of firms):

	Importance low 1	2	3	4	high 5	*Does not apply*
Price	2	6	21	24	40	7
Flexibility in responding to customer needs	0	2	9	27	56	6
Quality	0	0	5	11	81	3
Customer service	0	0	10	15	70	4
Customization of products	2	6	9	17	39	28
Offering a wide range of related products	12	6	14	16	20	32
Frequently introducing new and improved products	6	11	14	17	19	32

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms):

	Importance low 1	2	3	4	high 5	*Does not apply*
a) Management						
Continuous quality improvement	0	2	11	26	46	16
Using information technology	3	4	14	22	48	10
Delegating decision making	8	5	22	27	23	15

OTHER

C3 The criteria used to assess performance – *(continued)*

Financial Measures

33	% used cost of goods sold
34	% used total value of company
2	% used other financial criteria

Non-Financial Measures

22	% used market share
19	% used operating performance (down time etc.)
35	% used meeting quality standards
28	% used meeting delivery dates
3	% used other non-financial criteria

C4 Important factors to the *firm's* competitive strategy (percentage distribution of firms):

	Importance low 1	2	3	4	high 5	*Does not apply*
Price	4	4	12	26	49	6
Flexibility in responding to customer needs	1	1	6	30	56	6
Quality	1	0	7	21	68	3
Customer service	0	0	5	15	73	6
Customization of products	5	4	20	18	20	34
Offering a wide range of related products	7	4	19	23	20	27
Frequently introducing new and improved products	10	9	17	15	17	32

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms):

	Importance low 1	2	3	4	high 5	*Does not apply*
a) Management						
Continuous quality improvement	1	2	12	30	44	12
Using information technology	5	4	24	22	23	22
Delegating decision making	11	10	19	23	18	19

SCIENCE-BASED

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms): – *(continued)*

	Importance low 1	2	3	4	high 5	Does not apply
a) Management – (continued)						
Consensus decision making	5	6	16	30	22	21
b) Technology and R&D						
Developing new/refining existing technology	5	4	15	21	30	26
Purchasing others' technology	14	13	13	15	9	36
R&D capabilities	4	8	13	16	16	44
Protecting products/ processes with intellectual property rights	13	5	6	11	17	47
c) Human Resources						
Training	3	4	17	23	44	8
Recruiting skilled employees	6	6	11	23	43	12
Providing incentive compensation plans	10	4	26	14	20	25
d) Financing						
Finding and maintaining capital	17	9	18	17	22	17
Financial management	1	7	17	26	44	5
Flexibility in meeting unforeseen circumstances	4	1	21	30	32	12
e) Marketing						
Targeting new domestic markets	5	5	18	24	33	16
Targeting new foreign markets	12	6	9	14	20	38

OTHER

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms): – *(continued)*

	Importance low 1	2	3	4	high 5	Does not apply
a) Management – (continued)						
Consensus decision making	12	6	18	24	20	19
b) Technology and R&D						
Developing new/refining existing technology	9	2	13	11	13	53
Purchasing others' technology	10	7	8	10	10	55
R&D capabilities	11	3	8	7	6	66
Protecting products/ processes with intellectual property rights	14	2	5	7	6	66
c) Human Resources						
Training	5	6	18	21	34	16
Recruiting skilled employees	9	5	18	23	31	14
Providing incentive compensation plans	15	8	19	15	16	27
d) Financing						
Finding and maintaining capital	8	4	21	14	36	18
Financial management	1	3	14	19	57	6
Flexibility in meeting unforeseen circumstances	3	2	17	22	46	10
e) Marketing						
Targeting new domestic markets	8	4	12	19	27	29
Targeting new foreign markets	18	5	8	8	8	53

SCIENCE-BASED

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms): – *(continued)*

	Importance: low 1	2	3	4	high 5	Does not apply
e) Marketing – *(continued)*						
Improving position in existing markets	1	1	15	19	49	15
Satisfying existing customers	0	0	1	16	82	2
Promoting company or product reputation	1	5	5	16	58	14
Using third party distributors	18	11	10	5	14	42
f) Production						
Improving efficiency of input use	1	4	16	23	28	28
Reducing production times	1	5	11	26	27	31
Using computer controlled processes	4	4	10	21	28	33
Using high quality suppliers	0	1	9	21	38	31

C6 Changes in the firm's capabilities over the past 5 years in the following areas (percentage distribution of firms):

	weakened 1	2	no change 3	4	improved 5
Management	0	1	45	36	18
Financing	6	5	49	30	10
Human resource planning and development	8	4	53	27	7
Production	0	7	41	36	15
Technological	0	1	27	44	27
Innovation	0	3	45	36	17
Marketing	2	7	41	37	13

OTHER

C5 The importance of various strategies to the ongoing success of the firm (percentage distribution of firms): – *(continued)*

	Importance: low 1	2	3	4	high 5	Does not apply
e) Marketing – *(continued)*						
Improving position in existing markets	2	1	13	23	39	21
Satisfying existing customers	1	0	3	16	73	6
Promoting company or product reputation	2	5	7	21	47	18
Using third party distributors	20	5	10	8	6	52
f) Production						
Improving efficiency of input use	3	2	11	20	27	36
Reducing production times	5	3	12	14	22	44
Using computer controlled processes	8	5	12	10	14	52
Using high quality suppliers	2	1	8	21	38	30

C6 Changes in the firm's capabilities over the past 5 years in the following areas (percentage distribution of firms):

	weakened 1	2	no change 3	4	improved 5
Management	1	2	43	32	22
Financing	2	7	51	28	11
Human resource planning and development	1	8	64	19	9
Production	2	5	61	20	13
Technological	2	5	56	19	18
Innovation	2	9	52	23	14
Marketing	2	7	49	28	13

SCIENCE-BASED

C6 Changes in the firm's capabilities over the past 5 years in the following areas (percentage distribution of firms)**:** – *(continued)*

	1 *weakened*	2	3 *no change*	4	5 *improved*
Customer service	0	2	23	44	30
Supplier relations	3	2	54	26	15

Section D: Innovation

D1 50 % of firms introduced innovations during the 1992 to 1994 period

An innovation is the introduction of a new or improved product or process. Excluded are aesthetic changes that did not change the technical construction or performance of the product.

D2
- 70 % of innovators introduced entirely new products
- 63 % of innovators modified existing products
- 21 % of innovators introduced entirely new processes
- 51 % of innovators modified existing processes

D3 33 % of innovators had intellectual property rights (patents, trade secrets) for innovations

Section E: Investment

E1 a) For the fiscal year ending in 1994, investment expenditure was divided as follows:

- 20 % R&D for products or processes
- 22 % Technology acquisition and licensing (incl. computer hardware and software)
- 16 % Market development
- 10 % Training
- 11 % Machinery and equipment (incl. Capital leases)
- 4 % Land and buildings
- 5 % Upgrades to existing land, machinery or equipment
- 3 % Acquiring other businesses
- 8 % Other expenditures

OTHER

C6 Changes in the firm's capabilities over the past 5 years in the following areas (percentage distribution of firms)**:** – *(continued)*

	1 *weakened*	2	3 *no change*	4	5 *improved*
Customer service	0	1	24	40	34
Supplier relations	1	2	42	29	26

Section D: Innovation

D1 21 % of firms introduced innovations during the 1992 to 1994 period

An innovation is the introduction of a new or improved product or process. Excluded are aesthetic changes that did not change the technical construction or performance of the product.

D2
- 45 % of innovators introduced entirely new products
- 48 % of innovators modified existing products
- 42 % of innovators introduced entirely new processes
- 55 % of innovators modified existing processes

D3 10 % of innovators had intellectual property rights (patents, trade secrets) for innovations

Section E: Investment

E1 a) For the fiscal year ending in 1994, investment expenditure was divided as follows:

- 4 % R&D for products or processes
- 18 % Technology acquisition and licensing (incl. computer hardware and software)
- 9 % Market development
- 11 % Training
- 27 % Machinery and equipment (incl. Capital leases)
- 9 % Land and buildings
- 13 % Upgrades to existing land, machinery or equipment
- 3 % Acquiring other businesses
- 6 % Other expenditures

SCIENCE-BASED

E1 b) For the fiscal year ending in 1994, average investment expenditure amounted to:
('000 $)

$ 66 R&D for products or processes
$ 33 Technology acquisition and licensing (incl. computer hardware and software)
$ 32 Market development
$ 19 Training
$ 48 Machinery and equipment (incl. Capital leases)
$ 9 Land and buildings
$ 4 Upgrades to existing land, machinery or equipment
$ 4 Acquiring other businesses
$ 31 Other expenditures

Section F: Workers

F1
68 % of firms had 1 to 9 employees,
19 % of firms had 10-24 employees,
6 % of firms had 25-49 employees,
5 % of firms had 50-99 employees,
1 % of firms had 100 to 199 employees,
1 % of firms had more than 200 employees.

F2 63 % of the firms gave their workers formal training in 1994.

(including on-the-job and off-the-job training)

Section G: Revenues

G1 Total revenues for the fiscal year ending in 1994 averaged $ 1.8 million per firm.

G2
36 % of firms exported outside of Canada.
40 % of sales accounted for, by exports, among exporters

G3 The highest percentage of total revenues accounted for by a single customer was:

8 % reported 0% to 4%
8 % reported 5% to 9%
42 % reported 10% to 24%
25 % reported 25% to 49%
13 % reported 50% to 89%
3 % reported 90% to 100%

OTHER

E1 b) For the fiscal year ending in 1994, average investment expenditure amounted to:
('000 $)

$ 5 R&D for products or processes
$ 14 Technology acquisition and licensing (incl. computer hardware and software)
$ 8 Market development
$ 5 Training
$ 60 Machinery and equipment (incl. Capital leases)
$ 24 Land and buildings
$ 12 Upgrades to existing land, machinery or equipment
$ 2 Acquiring other businesses
$ 20 Other expenditures

Section F: Workers

F1
75 % of firms had 1 to 9 employees,
15 % of firms had 10-24 employees,
6 % of firms had 25-49 employees,
3 % of firms had 50-99 employees,
1 % of firms had 100 to 199 employees,
0 % of firms had more than 200 employees.

F2 52 % of the firms gave their workers formal training in 1994.

(including on-the-job and off-the-job training)

Section G: Revenues

G1 Total revenues for the fiscal year ending in 1994 averaged $ 1.6 million per firm.

G2
11 % of firms exported outside of Canada.
25 % of sales accounted for, by exports, among exporters

G3 The highest percentage of total revenues accounted for by a single customer was:

40 % reported 0% to 4%
14 % reported 5% to 9%
20 % reported 10% to 24%
10 % reported 25% to 49%
10 % reported 50% to 89%
6 % reported 90% to 100%

SCIENCE-BASED

G4 The percentage of total revenues that came from repeat customers:

- 7 % reported 0% to 4%
- 0 % reported 5% to 9%
- 7 % reported 10% to 24%
- 10 % reported 25% to 49%
- 54 % reported 50% to 89%
- 22 % reported 90% to 100%

G5 Over the next two years (1995, 1996) the amount that the firm's revenues were predicted to grow:

- 38 % reported 0% or decline
- 14 % reported 1% to 4%
- 16 % reported 5% to 9%
- 13 % reported 10% to 14%
- 13 % reported 15% to 24%
- 6 % reported more than 25%

G6 Firms were asked to stipulate the state of the market that best described their primary product.

- 9 % reported being located in an industry where product demand was just starting to grow *(introductory)*, but the product was still unknown to many potential users.
- 28 % reported being located in an industry where product demand was growing *(growth)* and the product was becoming familiar to many potential users.
- 47 % reported being located in an industry where product demand growth was slowing *(maturity)* and that the product was familiar to most potential users.
- 16 % reported being located in an industry where there was no growth in product demand *(post maturity)* and there were few potential new users.

Section H: Financing

H1 21 % of firms reported having a written financial plan

H2 Of those firms reporting having a financial plan:

- 67 % included historical financial data
- 98 % included a financial budget for the year
- 52 % included a financial forecast beyond the current year

OTHER

G4 The percentage of total revenues that came from repeat customers:

- 10 % reported 0% to 4%
- 4 % reported 5% to 9%
- 8 % reported 10% to 24%
- 12 % reported 25% to 49%
- 43 % reported 50% to 89%
- 24 % reported 90% to 100%

G5 Over the next two years (1995, 1996) the amount that the firm's revenues were predicted to grow:

- 26 % reported 0% or decline
- 26 % reported 1% to 4%
- 24 % reported 5% to 9%
- 12 % reported 10% to 14%
- 10 % reported 15% to 24%
- 3 % reported more than 25%

G6 Firms were asked to stipulate the state of the market that best described their primary product.

- 2 % reported being located in an industry where product demand was just starting to grow *(introductory)*, but the product was still unknown to many potential users.
- 29 % reported being located in an industry where product demand was growing *(growth)* and the product was becoming familiar to many potential users.
- 51 % reported being located in an industry where product demand growth was slowing *(maturity)* and that the product was familiar to most potential users.
- 18 % reported being located in an industry where there was no growth in product demand *(post maturity)* and there were few potential new users.

Section H: Financing

H1 19 % of firms reported having a written financial plan

H2 Of those firms reporting having a financial plan:

- 88 % included historical financial data
- 94 % included a financial budget for the year
- 56 % included a financial forecast beyond the current year

SCIENCE-BASED

H3

- 41 % of the firms had their financial plan reviewed by a board of directors with outside members
- 14 % of the firms had their financial plan reviewed by an independent certified financial advisor
- 76 % of the firms had their financial plan reviewed by employees of the firm
- 14 % of the firms had their financial plan reviewed by others outside the firm

H4 The frequency that the following forecasts were updated in the firm:

Income Statement

- 24 % did not update
- 35 % updated forecasts monthly
- 16 % updated forecasts quarterly
- 26 % updated forecasts annually

Balance Sheet

- 25 % did not update
- 32 % updated forecasts monthly
- 13 % updated forecasts quarterly
- 31 % updated forecasts annually

Cash Flow Statement

- 30 % did not update
- 40 % updated forecasts monthly
- 11 % updated forecasts quarterly
- 19 % updated forecasts annually

Capital Expenditures

- 34 % did not update
- 20 % updated forecasts monthly
- 16 % updated forecasts quarterly
- 30 % updated forecasts annually

H5 a) The breakdown of the firm's debt, equity, and other types of financing:

- 45 % Retained earnings
- 12 % Share capital
- 8 % Trade credit
- 0 % Convertible debentures
- 4 % Contract financing (advance payments or loans from customers)
- 12 % Short-term secured loans
- 4 % Short-term unsecured loans
- 9 % Long-term secured loans
- 4 % Long-term unsecured loans
- 1 % Investment tax credits
- 0 % Grants
- 2 % Other

OTHER

H3

- 20 % of the firms had their financial plan reviewed by a board of directors with outside members
- 36 % of the firms had their financial plan reviewed by an independent certified financial advisor
- 60 % of the firms had their financial plan reviewed by employees of the firm
- 26 % of the firms had their financial plan reviewed by others outside the firm

H4 The frequency that the following forecasts were updated in the firm:

Income Statement

- 22 % did not update
- 31 % updated forecasts monthly
- 10 % updated forecasts quarterly
- 36 % updated forecasts annually

Balance Sheet

- 21 % did not update
- 31 % updated forecasts monthly
- 10 % updated forecasts quarterly
- 38 % updated forecasts annually

Cash Flow Statement

- 25 % did not update
- 37 % updated forecasts monthly
- 8 % updated forecasts quarterly
- 30 % updated forecasts annually

Capital Expenditures

- 30 % did not update
- 17 % updated forecasts monthly
- 10 % updated forecasts quarterly
- 42 % updated forecasts annually

H5 a) The breakdown of the firm's debt, equity, and other types of financing:

- 38 % Retained earnings
- 8 % Share capital
- 11 % Trade credit
- 0 % Convertible debentures
- 2 % Contract financing (advance payments or loans from customers)
- 11 % Short-term secured loans
- 4 % Short-term unsecured loans
- 17 % Long-term secured loans
- 3 % Long-term unsecured loans
- 0 % Investment tax credits
- 0 % Grants
- 4 % Other

SCIENCE-BASED

H5 b) The breakdown of the average firm's debt, equity, and other types of financing: ('000 $)[1]

$ 402	Retained earnings
$ 166	Share capital
$ 77	Trade credit
$ 3	Convertible debentures
$ 87	Contract financing (advance payments or loans from customers)
$ 108	Short-term secured loans
$ 11	Short-term unsecured loans
$ 108	Long-term secured loans
$ 20	Long-term unsecured loans
$ 12	Investment tax credits
$ 2	Grants
$ 8	Other

H6 a) The amount of the firm's debt which came from each of the following sources for the fiscal year ending in 1994:

45	% Retained earnings
16	% Owner managers
7	% Suppliers
2	% Customers (loans or advance payments)
2	% Related firms
22	% Banks and Trust companies
0	% Joint ventures, strategic alliances
1	% Venture capitalists, merchant banks, capital groups
0	% Pension funds and insurance companies
0	% Employees
1	% Private investors (silent partners)
2	% Governments
1	% Public market
1	% Others

H6 b) The amount of the average firm's debt which came from each of the following sources for the fiscal year ending in 1994: ('000 $)[1]

$ 402	Retained earnings
$ 133	Owner managers
$ 75	Suppliers
$ 37	Customers (loans or advance payments)
$ 58	Related firms
$ 197	Banks and Trust companies
$ 0	Joint ventures, strategic alliances
$ 47	Venture capitalists, merchant banks, capital groups

OTHER

H5 b) The breakdown of the average firm's debt, equity, and other types of financing: ('000 $)[1]

$ 253	Retained earnings
$ 95	Share capital
$ 80	Trade credit
$ 1	Convertible debentures
$ 8	Contract financing (advance payments or loans from customers)
$ 80	Short-term secured loans
$ 20	Short-term unsecured loans
$ 186	Long-term secured loans
$ 23	Long-term unsecured loans
$ 2	Investment tax credits
$ 3	Grants
$ 18	Other

H6 a) The amount of the firm's debt which came from each of the following sources for the fiscal year ending in 1994:

38	% Retained earnings
12	% Owner managers
7	% Suppliers
1	% Customers (loans or advance payments)
2	% Related firms
35	% Banks and Trust companies
1	% Joint ventures, strategic alliances
0	% Venture capitalists, merchant banks, capital groups
0	% Pension funds and insurance companies
0	% Employees
1	% Private investors (silent partners)
1	% Governments
0	% Public market
2	% Others

H6 b) The amount of the average firm's debt which came from each of the following sources for the fiscal year ending in 1994: ('000 $)[1]

$ 253	Retained earnings
$ 90	Owner managers
$ 58	Suppliers
$ 7	Customers (loans or advance payments)
$ 19	Related firms
$ 273	Banks and Trust companies
$ 4	Joint ventures, strategic alliances
$ 6	Venture capitalists, merchant banks, capital groups

SCIENCE-BASED

H6 b) The amount of the average firm's debt which came from each of the following sources for the fiscal year ending in 1994: ('000 $)[1] – *(continued)*

- $ 1 Pension funds and insurance companies
- $ 0 Employees
- $ 5 Private investors (silent partners)
- $ 17 Governments
- $ 11 Public market
- $ 21 Others

H7 The performance conditions attached to the provision of the firm's external financing

- 42 % of firms had no external financing
- 59 % of the firms with external financing had no performance conditions attached

Of those firms with performance conditions attached, the percentage having the following conditions.

Financial Measures

- 18 % achieve the operating break-even point
- 20 % revenue growth
- 35 % net income growth
- 37 % cash flow
- 22 % debt/equity ratio
- 21 % return on assets ratio
- 14 % return on sales ratio
- 3 % return on equity
- 2 % return on R&D ratio
- 34 % cost of goods sold
- 42 % total value of company
- 17 % other conditions

Non-Financial Measures

- 11 % market share
- 13 % operating performance (down time, etc.)
- 20 % meeting quality standards
- 19 % meeting delivery dates
- 4 % other conditions

OTHER

H6 b) The amount of the average firm's debt which came from each of the following sources for the fiscal year ending in 1994: ('000 $)[1] – *(continued)*

- $ 1 Pension funds and insurance companies
- $ 3 Employees
- $ 5 Private investors (silent partners)
- $ 15 Governments
- $ 17 Public market
- $ 18 Others

H7 The performance conditions attached to the provision of the firm's external financing

- 39 % of firms had no external financing
- 64 % of the firms with external financing had no performance conditions attached

Of those firms with performance conditions attached, the percentage having the following conditions.

Financial Measures

- 31 % achieve the operating break-even point
- 20 % revenue growth
- 51 % net income growth
- 47 % cash flow
- 44 % debt/equity ratio
- 9 % return on assets ratio
- 23 % return on sales ratio
- 7 % return on equity
- 1 % return on R&D ratio
- 17 % cost of goods sold
- 48 % total value of company
- 7 % other conditions

Non-Financial Measures

- 20 % market share
- 9 % operating performance (down time, etc.)
- 11 % meeting quality standards
- 14 % meeting delivery dates
- 0 % other conditions

[1] *The mean percentages reported in H5a (H6a) are not equal to the percentages that could be derived from the mean dollar amounts reported in H5b (H6b) because the former are calculated as unweighted proportions and then averaged, whereas the latter would, in effect, be weighted proportions.*

SCIENCE-BASED

H8 How the firm financed each of the following:

Check all methods used to finance the following

Use of funds	***Did not devote funds to this category***	***Types of funds***												
		Retained earnings	***Share capital***	***Trade credit***	***Contract financing***	***Line of credit***	***Short-term secured loans***	***Short-term unsecured loans***	***Long-term secured loans***	***Long-term unsecured loans***	***Convertible debentures***	***Investment tax credits***	***Grants***	***Other***
R&D innovation of products or processes	65	26	5	1	4	5	1	0	0	0	0	7	4	1
Technology acquisition and licencing (incl. computer hardware and software)	55	36	6	2	2	5	6	6	1	0	0	3	0	1
Market development	50	36	6	4	2	5	3	0	1	0	0	2	1	1
Training	43	41	3	2	2	6	5	0	0	0	0	7	3	1
Machinery and equipment (including capital leases)	61	24	2	5	0	7	2	0	3	0	0	0	0	1
Land & buildings	84	6	2	1	0	1	0	0	7	0	0	0	0	0
Upgrades to existing land, machinery or equipment	88	7	3	0	0	2	0	1	1	0	0	0	0	0
Acquisition of other businesses	92	4	2	0	0	0	0	0	0	0	0	0	0	0
Working capital	53	29	8	4	0	14	7	5	2	0	0	3	0	1
Financial cushion for uncertainties	64	22	5	0	0	12	2	0	0	0	0	1	0	3
Debt reduction	82	10	2	0	0	6	0	0	0	0	0	0	0	0
Other uses of funds	92	7	1	0	0	1	0	0	0	0	0	0	0	0

OTHER

H8 How the firm financed each of the following:

Check all methods used to finance the following

Use of funds	Did not devote funds to this category	Types of funds: Retained earnings	Share capital	Trade credit	Contract financing	Line of credit	Short-term secured loans	Short-term unsecured loans	Long-term secured loans	Long-term unsecured loans	Convertible debentures	Investment tax credits	Grants	Other
R&D innovation of products or processes	86	8	1	0	0	3	0	0	0	0	0	0	1	1
Technology acquisition and licencing (incl. computer hardware and software)	69	18	1	1	2	3	5	0	3	0	0	0	0	3
Market development	76	14	1	1	1	3	1	0	1	0	0	0	0	2
Training	65	26	1	1	0	5	1	0	1	0	0	0	0	1
Machinery and equipment (including capital leases)	57	20	2	3	4	4	7	1	8	0	0	0	0	1
Land & buildings	81	7	2	1	1	1	2	0	8	0	0	0	0	1
Upgrades to existing land, machinery or equipment	71	15	1	3	2	5	5	0	4	0	0	0	0	1
Acquisition of other businesses	94	2	0	1	1	2	1	0	1	0	0	0	0	0
Working capital	52	24	3	5	1	17	4	1	2	0	0	0	0	2
Financial cushion for uncertainties	69	15	1	0	0	11	2	0	0	0	0	0	0	2
Debt reduction	77	15	1	1	1	2	0	0	1	0	0	0	0	3
Other uses of funds	86	6	0	0	1	1	1	0	0	0	0	0	0	3

Appendix B

A List of Science-Based Industries

Sic Code	Description
0231	Agricultural Management and Consulting Services
0239	Other Services Incidental to Agriculture n.e.c.
3111	Agricultural Implement Industry
3121	Commercial Refrigeration and Air Conditioning Equipment Industry
3191	Compressor, Pump and Industrial Fan Industry
3192	Construction and Mining Machinery and Materials Handling Equipment Industry
3193	Sawmill and Woodworking Machinery Industry
3194	Turbine and Mechanical Power Transmission Equipment Industry
3199	Other Machinery and Equipment Industries, n.e.c.
3211	Aircraft and Aircraft Parts Industry
3341	Record Player, Radio and Television Receiver Industry
3351	Telecommunication Equipment Industry
3352	Electronic Parts and Components Industry
3359	Other Communication and Electronic Equipment Industry
3361	Electronic Computing and Peripheral Equipment Industry
3362	Electronic Office, Store and Business Machine Industry
3369	Other Office, Store and Business Machine Industries
3371	Electrical Transformer Industry
3372	Electrical Switchgear and Protective Equipment Industry
3379	Other Electrical Industrial Equipment Industries
3381	Communications and Energy Wire and Cable Industry
3611	Refined Petroleum Products Industry (except lubricating oil and grease)
3612	Lubricating Oil and Grease Industry
3699	Other Petroleum and Coal Products Industries
3711	Industrial Inorganic Chemical Industries n.e.c.
3712	Industrial Organic Chemical Industries n.e.c.
3721	Chemical Fertilizer and Fertilizer Materials Industry
3722	Mixed Fertilizer Industry
3729	Other Agricultural Chemical Industries
3731	Plastic and Synthetic Resin Industry
3741	Pharmaceutical and Medicine Industry
3791	Printing Ink Industry

3792	Adhesives Industry
3799	Other Chemical Products Industries n.e.c.
3911	Indicating, Recording and Controlling Instruments Industry
3912	Other Instruments and Related Products Industry
3913	Clock and Watch Industry
3914	Ophthalmic Goods Industry
4611	Natural Gas Pipeline Transport Industry
4612	Crude Oil Pipeline Transport Industry
4619	Other Pipeline Transport Industries
4814	Cable Television Industry
4821	Telecommunication Carriers Industry
4839	Other Telecommunication Industries
4911	Electric Power Systems Industry
7721	Computer Services
7751	Offices of Architects
7752	Offices of Engineers
7759	Other Scientific and Technical Services
9611	Motion Picture and Video Production
9619	Other Motion Picture, Audio and Video Services

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