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R&D Strategy-Makings in Japanese Large Firms: Evidence from Questionnaire Survey

Noriyuki Doi
Kwansei Gakuin University

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SCHOOL OF ECONOMICS

KWANSEI GAKUIN UNIVERSITY

1-155 Uegahara Ichiban-cho
Nishinomiya 662-8501, Japan

Comments Welcome

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Abstract

The paper presents the findings from a questionnaire sent to senior corporate staff members. Some major features of the R&D strategy-makings among Japanese large firms are summarized as follows: (1) Japanese large firms undertake R&D activity, relatively independently of capital market pressures; (2) Recent strategic emphasis of R&D is toward product innovations rather than toward process innovations; (3) Emphasis in the sourcing of new technologies is on in-house development and joint R&D ventures with customers and suppliers. In particular, many of large firms undertake joint research with small- and medium-sized firms; (4) R&D is largely marketing-driven. Firms are concerned with rivals' behavior, but the influences of pressures from rivals may be modest; (5) Firms tend to focus on a limited number of R&D projects; (6) Large firms do not apply all of the new inventions for patents. But, firms place much importance on international patent applications; (7) There are some differences in perception to R&D strategy-makings between technological and administrative respondents, reflecting the difference in viewpoint and responsibility.

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** Professor of Economics,
Department of Economics,
Kwansei Gakuin University,
Nishinomiya, 662 Japan.
Office's TEL & FAX: + 81 (0)798 54 6316
E-mail: noriyuki@kgupyr.kwansei.ac.jp

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Noriyuki Doi*

I Introduction

There is little doubt that R&D and innovations are the driving forces of a firm's growth and viability, and further, of industrial and economic development. Therefore, a great number of studies have examined the factors affecting R&D and innovations in a theoretical and/or empirical way(1). In particular, pressures from capital market and rivalry are interesting from the viewpoint of corporate strategy and public policy.

In addition, the problem is of critical importance in Japan. The rise of Japanese large firms to a position of global leaders has been attributable to their innovations(2). The rise may be captured by an increasing share of Japanese industries in patents granted in the U.S. : Japan's share has been increased from 11.6 percent of the world total in 1980 to 21.8 percent in 1991, and also from 29.0 percent of the non-US total in 1980 to 46.3 percent in 1991 (Doi[1994, p.24]).

However, doubts are now growing over the competitiveness of Japanese industries. Whether the argument holds true may depend greatly on their future technological development, since their cost minimizations are approaching the limit for two-fold reasons: first, labor costs are of the highest level in the world; secondly, cost controls through subcontracting are more difficult. Also, in the fields in which Japanese industries have advantages, its dominance may be eroded by challenges from the Asian growth centre. Deadlocks facing Japan may be reduced by continuing new technology development.

In order to disentagle the industrial dynamism and evolution, it is important to examine the possible determinants of firms' R&D activity, or the relations between the environment, corporate governance and R&D strategy. Most of the existing studies have centered largely on the effects upon R&D of market structure elements like firm size, concentration and product differentiation. And those approaches are econometric. But, it is difficult to capture the effects of qualitative factors like capital market pressures and corporate structure. Therefore, study is scarce which examines the effects in Japan.

In this paper, answers were provided for the problems of the effects of

administrative responses in a company.

Table 1 shows the distribution, by sector (*i.e.*, 2-digit industry), of destinations and responses (respondents and firms). 60 percent of the responses (and also of the firms which replied) are from the three "progressive" sectors of chemicals, electrical machinery and transportation equipment. There is no large difference in distribution between the destination and the response (firm and respondent). Also, these sample firms, as suggested above, occupy a large share of Japanese R&D activity in Japan which is measured by R&D expenditures and patents (Doi[1994, 1996]).

《Table 1》

It should be noted that although the questionnaire was sent to board members (*i.e.*, executive directors), frequently replies came from non-executive directors. Also, the respondents include persons responsible for managerial strategy-plannings or public relations, not for R&D and finance[5]. They indicated that their responses were the official statements of their companies.

Therefore, the responses were divided into largely two subgroups: "technological" and "administrative" ones. Most of the technological responses came from executive directors. In spite of the diversity in respondents, the responses are meaningful, though prudence is necessary for international comparisons.

There are some methodologies for answering questions. First, respondents were asked to rate the importance of several possible factors and statements to the decision, promotion and success of R&D strategy. Rating was in most cases on a scale of "1 to 5". Second, the "yes/no" type questions were provided for them. Finally, respondents were asked to select the contents which they think are most suitable for their own views. Also, a complementary series of phone or face-to-face interviews were conducted. From these methodologies, we can suggest the common understandings or evaluations which are prevalent among directors or managers in large firms.

The number of respondents are different from question to question, since some respondents sometimes did not reply to questions.

The general features of R&D activity in Japanese large firms, of which some are a sample here, are discussed in Doi[1994, 1996] in more detail.

III Results from the Questionnaire

Now we will examine the results from the questionnaire in turn. The results are shown in Tables 2-T～10-T for the technological responses, and in Tables 2-A～10-A for the administrative responses. These tables show the number and percentage of respondents indicating a particular scale in response to questions,

based on the rating of a scale of 1 to 5. The results for the yes/no type questions and others are shown in Tables 11-T and 12-T for the technological responses, and in Tables 11-A and 12-A for the administrative responses. The tables show the mentions, their distributions and means.

1 Pressures from Capital Markets: the Time Horizon of R&D Strategy

The time horizon of management in Japanese large firms is said to be long-term thinking and decision, or "long-termism", while European and US counterparts are "short-termism"[8]. In Japan, such long-termism is argued to be shared by shareholders, banks, management, workers, suppliers and customers. We wanted to understand the time horizon in R&D strategy-makings. The time horizon may be related to the degree of the pressures from capital markets. The results for the problem are shown in Tables 2-T and 2-A.

《Table 2-T》

《Table 2-A》

Questions 1(1) and (2) are concerned with the problem. The responses from the two subgroups both suggest that the pressures of shareholders on R&D projects are relatively small, being consistent with the managerial independence and long-termism of Japanese large firms. First, 77 percent (both scale 1 and 2) of technological responses "disagree" with the statement that it is difficult to provide profit figures which satisfy shareholders whilst funding R&D projects which are right for the business (Question 1(1)). Also, 88 percent of the administrative responses said that the statement did not hold true for their companies. Then, in both the responses, "scale 2" (*i.e.*, "disagree") outranks "scale 1" (*i.e.*, "disagree strongly") in the mention. The mean mention rates of 2.023 and 1.900 both reflect these responses. In this question, R&D staffs are suggested to become more aware of the trade-off between shareholder pressures and R&D long-termism.

This finding suggests the attitudes of banks as well, since banks and in particular city banks are frequently major shareholders as well as providers of long-term funds. Therefore, long-termism is shared by banks.

There is no large difference in the ratio of disagreement across industry, and in particular among three progressive industries: chemicals, electrical machinery, and transportation equipment. The ratios of disagreement for the technological and the administrative responses are respectively; 76.7 and 84.6 percent for chemicals; 69.0 and 84.4 percent for electrical machinery; and 76.2 and 73.0 percent for transportation equipment.

Second, 84 percent of the technological responses and 91 percent of the administrative responses respectively disagree with the statement that the company frequently experiences pressures for short-term profit maximisation from

the shareholders and therefore sometimes cancel projects which ought to be undertaken in the long-term interest of the company (Question 1(2)). A similar frequency was provided for both "scale 1 and 2". Then, the mean mention rate is 1.847 for the technological respondents, and 1.692 for the administrative respondents. Also, it is worth noting that the "perceived independence" is a little larger for the administrative respondents than for the technological respondents.

The above results are consistent with the findings from both the technological and administrative responses for Questions 1(3)～(6). First, they do not think that they have received negative influences from major shareholders. Rather, many senior corporate staff members do not provide a high evaluation for the capability of analysts and major shareholders to assess R&D projects (Questions 1(3)). Also, they do not think that their major shareholders and analysts exhibit a strong bias against high-risk, long-term research in favor of low-risk, short-term product development (Question 1(4)). There are only 16 percent of the technological respondents and 7 percent of the administrative respondents who agree with the statement.

Second, most of the respondents believe that their firms are scarecely likely to be acquired (Question 1(5)); 97 percent of the technological responses and also of the administrative responses both replied that their firms were not a possible target (*i.e.*, acquiree) of M&A, and therefore were not subject to the negative pressures of possible acquisitions on R&D projects. In particular, more than 80 percent of the respondents suggest the "strong disagreement." In fact, although mergers and acquisitions do take place, they are generally agreed, and contested takeovers are rare. In this sense, a market for corporate control hardly works. But, they never make light of the relationships with capital markets (Question 1(6)). It may be because in recent years Japanese large firms prefer equity financings to bank borrowings.

Many respondents indicated their comments on these questions at the end of the questionnaire sheet. The comment was that these statements were suitable for the US and European firms, while not for Japanese firms. Their comments also support the above conclusion.

Next, interestingly, there is a difference in the understanding of whether information for shareholders was improved relative to before, between the technological and administrative responses; more of the administrative responses think that shareholders are better informed than ten years ago, while the technological respondents are a little unsure of the problem (Question 1(7)). Scientists and engineers may be less interested in the disclosure of information, but, there is an agreement, between both the subgroups, on the statement that shareholders demand more information (Question 1(8)).

However, over half of the responses, both technological and administrative, replied, using the yes/no type method, that their companies had not felt a need to improve the information supplied to shareholders . The response rate of "yes" is 67.8 percent (118 out of 174) for the technological respondents, and 54.2 percent (65 out of 120) for the administrative respondents (which are not shown in Tables 11-T and 11-A). The reason is the result for Question 1(7); they think that shareholders are better informed. Also, as Tables 11-T and 11-A show, there are only a little more than half of the respondents of which the companies have staffs at a senior level responsible for shareholder relations (Question 10(1)); 53 percent for the technological responses, and 56 percent for the administrative responses.

Thus, overall and bearing in mind the qualifications of the questionnaire survey, we can conclude that both the persons responsible for R&D and administration have a relatively high perception of independence and long-termism. Put alternately, they have no perception of short-termism in the sense of capital market pressures. Therefore, in general Japanese firms undertake R&D, independently of the pressures from capital markets. The conclusion is consistent with the widely-accepted hypothesis of the independence and long-termism of management in Japanese large firms. Further, it is related to the fact that "stable or committed shareholders" have a large percentage of shareholdings in Japanese large firms, or that mutual share-holdings are prevalent across firms. "Industrial groupings" or "keiretsu" may be beneficial for long-termism-based strategy-makings.

2 Strategic Emphasis of R&D

The time horizon of R&D strategy-makings may be inter-related to some aspects of R&D: strategic emphasis, sourcing of new technology, company structure, and budjets and evaluation of R&D. We will discuss these aspects in turn.

Now, we will refer to the evidence on the "strategic emphasis" of R&D behavior. The results are concerned with; (i) R&D incentive and the life cycle of an industry (Also see Section III.4 which refers to the time horizon of R&D), (ii) the kind of R&D and innovation, (iii) the relations with transaction partners and rivals, and (iv) the sources of new technologies. The results for the questions are shown in Tables 3-T and 3-A.

《Table 3-T》

《Table 3-A》

First, a distinction is usually drawn between product and process innovation. The technological responses for Questions 2(1) and (2) suggest that their companies have a little stronger preference for product innovation than for

process innovation. This suggestion is supported by the results for Questions 2(3) and (5). Therefore, firms in a mature industry tend to diversify into new fields by developing new products.

It is often said that one of the characteristics of R&D in Japan is its orientation toward process innovations rather than product innovations (EPA[1992, p.300] and Mansfield[1988a, b]). But, according to the present findings, in recent years firms prefer product innovations to process innovations, reflecting "corporate restructuring" under way. Also, the finding is in accordance with the suggestion that Japanese firms have increased their "basic-oriented research" efforts for future profitable products, to promote further restructuring.

Second, many of the respondents think the R&D of their companies and the industries concerned is "marketing-driven" rather than "science-driven" (Questions 2(4) and (6)). For most of the firms, R&D activity is conducted in a marketing-pull context. This result involves some significant implications. First, internal marketing divisions and customers are likely to be an important information source for R&D. Second, it is important to bring together divisions (or staffs) involved in all vertically-related operations from R&D to marketing. Houlder[1996] calls the format "a seamless innovation process." For example, a flexible project team including staffs from the relevant divisions is frequently organized, and once completed, the project is turned over to the relevant manufacturing division, and then the team member return to their original divisions. Such project team is usually called "amoeba" or "task force."

The findings also imply that competition in a product market is important for R&D. Strategic emphasis is on product development based on user-needs and/or competition. Thus, R&D incentives come from firm competition, rather than capital market pressures.

Third, 66 percent of the technological respondents and 75 percent of the administrative respondents responded that in-house development is preferable to acquisitions or outsourcings (Question 2(7)). This result is further supported by one for Question 2(13); over 70 percent of the respondents, both technological and administrative, suggest the importance of "innovation through organic or internal growth". The response is consistent with the results for Questions 3(1)～(5) referred to later. Recently, it is indicated that more large firms are using external sources for R&D works: "Japanese businesses will increase their percentage reliance on external technology from 40 percent to 60 percent between 1993 and 1996" (Houlder[1995a]). Nevertheless, the present results do not provide support for this suggestion. If the percentage includes joint R&D ventures such as consortia and joint research with suppliers and customers referred to later, the indication may not be unconsistent with the

present results.

Many of the respondents suggest that joint research with customers and suppliers is important for attaining their competitive advantages[7] (Questions 2(8) and (9)). The less mentions of "much importance" (rate 4) and "very much importance" (rate 5) in the question on joint R&D operations with suppliers are attributable to the fact that less ratings were provided for the joint research with suppliers in chemicals with a smaller extent of vertical transaction.

In fact, as shown in Tables 11-T and 11-A, more of the respondents believe that joint research has contributed greatly to the profits and growth of their companies (Question 10(2)). Joint research may be reflected for example in an increasing number of joint patent applications by more than one company. Also, this result is consistent with the finding in Mansfield[1988a, p.227] that in Japan, R&D projects in firms have often been proposed by their customers, reflecting "learning by using," and with the above-mentioned finding that research is marketing-driven. Thus, the close inter-firm relationships (such as industrial groupings and keiretsu) are likely to have an influence on R&D activity; users and suppliers are an integral part of the R&D process. The close inter-firm relationships are part of the "architecture" which is emphasized by Kay[1993].

Furthermore in particular, as the result for Question 10(3) in Table 11-T suggests, it is worth noting that more than half (90 out of 168 firms. 54 percent) of the technological respondents' companies undertake joint R&D ventures with "small- and medium-sized enterprises" (*i.e.*, firms with less than 300 employees. Hereafter SMEs)[8]. This ratio is surprisingly high. And about half (116 out of 233 firms. 49.8 percent) of total available sample firms conduct joint research with SMEs. This fact implies that many of SMEs have a higher technological capability. Therefore, it is necessary to examine R&D behavior of SMEs.

In addition, industries with joint research with SMEs are not restricted to a few industries, as there is at least one firm conducting joint research in each sector. The number of firms conducting joint research with SMEs is for example; 4 for food; 6 for fiber and textile; 28 for chemicals; 9 for general machinery; 13 for electrical equipment; and 10 for transportation equipment. Therefore, the R&D partnership between large firms and SMEs as well as "cooperative R&D ventures" among large firms should beat the heart of some important theoretical developments in industrial organization and managerial economics.

Thus, the respondents emphasize the in-house development of new technology and joint R&D ventures with customers or suppliers. Yet, in-house development outranks joint ventures in strategic importance.

Fourth, the respondents, both technological and administrative, provide support for the statement that it is highly important to focus on a limited range of projects organized around a few core competences drawn up within the framework of a clear technology strategy (Question 2(10)). The ratio of respondents selecting either "scale 4 or 5" (which mean that the statement applies to their companies) is 78 percent for the technological responses, and 61 percent for the administrative responses. Therefore, there is now a widespread acceptance, in particular among technological staffs, that the "targeting" strategy in new technology development is important. The result is shared by STA[1994], as well. For example, in an electronics firm, R&D activity is focused on potential technologies in vertically-related fields. These findings may reflect the recent trends of both "more efficient R&D activity" and restructuring. Also, the findings imply that R&D organizations or systems are important for conducting effective innovations.

Fifth, somehow surprisingly, only half of the respondents think that the following statement in Question 2(11) does not apply to their companies; R&D expenditures are an overhead which like any other costs has to be trimmed back during a recession [9]. The result is consistent with the finding, from STA [1994], that R&D expenditures in the private firm sector have tended to decrease since 1992. But, large reduction of the expenditures may be impossible, since firms must take into account rivals' behavior.

This finding is rather against our expectation, since it is often said that Japanese large firms think of R&D expenditures as indispensable for establishing and maintaining long-term competitiveness, and thereby are reluctant to reduce the expenditures even during a recession. The finding may reflect that the current recession is very severe enough to induce the reduction of the expenditures. Also, this finding is consistent with the result for Question 2(10) that large firms tend to focus on a limited range of R&D projects.

Sixth, 77 percent of the technological respondents did not agree with the statement that their companies always attempted to match their rivals' R&D expenditures as percent of sales (Question 2(12)). The similar reply of disagreement was supported by 82 percent of the administrative respondents. This result is rather perplexing, since it is frequently indicated, as suggested earlier, that there is fierce technological competition among large Japanese firms. The respondents may mean that their companies determine R&D expenditures, based on the positive and comprehensive judgement. In fact, some respondents in our interviews suggested that they were concerned with rivals' R&D expenditures as percent of sales, but their concern was not overwhelming. One of the reasons was that the definition and scope of R&D expenditures published varied from firm to firm.

Seventh, unfortunately only 55 out of 177 technological respondents (*i.e.*, 31 percent) and also only 33 out of 120 administrative respondents (*i.e.*, 28 percent) refer to the ratio of R&D directors in the board of director, but the results are very interesting.

According to Tables 12-T and 12-A, 48 of 55 persons (*i.e.*, 87 percent) think that scientists and engineers should join the board more than, or at least equally to, the number of non-technological directors with accounting and legal qualifications. Also, 29 out of 33 persons (*i.e.*, 88 percent) for the administrative responses show a very similar view. After all, 88 percent (= 77/88) of respondents support the argument. These results may imply a greater importance of R&D and innovations in management, or greater impacts of R&D and innovations on management. The administrative respondents outnumber the technological respondents in the frequency of mention for the "about the same."

Finally, respondents were asked about whether their companies had R&D facilities in foreign countries (Question 10(4)). Overseas R&D operations are a very significant strategy, in particular for firms with global shift. As Tables 11-T and 11-A indicate, both 39 percent of the technological respondents and 39 percent of the administrative respondents suggest that their companies had overseas R&D operations. Thus, the extent of overseas R&D operations is relatively small among Japanese firms, although increasing in recent years. Therefore, at the present period there are a smaller number of technologies which came from overseas in-house R&D operations.

3 Development Sources for New Products

The next results are concerned with the sources of new product development. The above results suggest that in recent years, firms' emphasis is on product development rather than on process innovation. So, it is interesting to look at, in particular, the sources of new products. The problem is reflected in Questions 3(1)～(5). The results for the question are shown in Tables 4-T and 4-A.

《Table 4-T》

《Table 4-A》

Respondents were asked to rate the importance of five sources to the success of their new development: (1) in-house development, (2) joint R&D ventures, (3) acquisitions, (4) licensing, and (5) other. A greater number of respondents think that both in-house development and joint R&D venture are important as sources of new products. These results are consistent with those referred to earlier (*i.e.*, the results for Questions 2(7)～(9) and Question 10(2) in which new development includes new process as well as new product). Also, a relatively great emphasis is provided for licensing. This result is consistent

with the fact that Japanese firms have introduced and, unexpectedly, are now still introducing a great number of new technologies from overseas (EPA[1992]).

But concerning acquisitions, they feel it difficult to evaluate its effects. This attitude may be attributable, in part, to insufficient information of new inventions, or to unmature "markets for technology and corporate control" in Japan.

4 Strategic Planning and Company Structure

It is necessary to constantly redesign company structure and organization to exploit and promote new technologies. The examination here is about strategic planning and company structure. The results for the problems are shown in Tables 5-T～7-T and Tables 5-A～7-A.

《Table 5-T ～ 7-T》

《Table 5-A ～ 7-A》

Before tackling any specific questions on strategic planning of R&D and company structure, respondents were asked to show the time horizon of strategy-makings like the "average planning term" for their R&D and the "average life expectation" of their major products. The results are not shown in the Tables.

70 percent combined of the respondents, both technological and administrative, replied that the average planning term for their R&D was largely between 1 and 4 years; The frequency of mentions is 20.6 percent for the 1-2 years category; 29.1 percent for the 2-3 years category; and 21.2 percent for the 3-4 years category in the technological responses; Similarly, the frequency is 19.4 percent for the 1-2 years category, 29.6 percent for the 2-3 years category and 16.7 percent for the 3-4 years category in the administrative responses(10). These results are roughly similar to Mansfield's[1988b] finding that "projects expected to last more than 5 years" occupy 38 percent of total.

Next, the average product life expectation varies across respondents. Put alternately, the variation in time horizon is large. But, there are a relatively great number of respondents who suggest that the expectation is at least over 4 years. 77 percent (= 131/170) of the technological respondents and 65 percent (= 72/111) of the administrative respondents respectively replied that the expectation was 4 years and over.

Firms undertake R&D strategy within such time horizon of R&D planning and marketing. Then, firms were asked about the relationship between R&D strategy and company structure. First, there is no discernible pattern on the relationship in strategy-makings between a company's divisions and its headquarters. The following three statements have a roughly similar ratio of mentions (The results are not shown in this paper): (1) the headquarter takes an active role in participating in the formulation of strategy within and across

divisions; (2) the headquarter reviews strategy formulated within the divisions, but does not itself advocate strategic plans; (3) the divisions formulate strategy autonomously subject to tight financial controls from the headquarter. The distributions display no cluster of respondents. Thus, there seems to be large variation in the relationship between divisions and their headquarters across firm.

Second, 123 technological and 67 administrative respondents whose companies are multi-divisional in structure were asked about the effects of organizational structure on R&D (Questions 4(1)～(5)). The views of the problem suggest no definite pattern except two questions (Questions 4(3) and (5)). 74 percent of the technological respondents agree with the statement that if strategic planning of R&D is reduced to purely financial equations, then it fails (Question 4(3)). But, the ratio for the administrative responses is 55 percent. This difference in the recognition is likely to be attributable to the difference in responsibility. Scientists and engineers tend to emphasize technological performance, while administrative staffs prefer the "costs/ benefits-conscious" approach to technology-oriented evaluations.

Also, 59 percent of the technological respondents agree with the statement that it is necessary to adopt structures which protect long-term research against shorter-term applied research and product development (Question 4(5)). Put alternately, company structure may have an influence on the characteristics of R&D projects. A type of corporate structure may be oriented toward shorter-term R&D. Recently, STA[1994] indicates that many firms have changed R&D systems and organizations. The changes may reflect attitudes toward R&D. On the contrary, only 46 percent of the administrative respondents agree with the statement. This observed variation in response rate also may reflect the difference in viewpoint and responsibility between the technological and administrative respondents.

These two questions may be related to short-termism of R&D. In general, the time horizon of R&D strategy-makings is likely to be affected by internal factors as well as external factors such as pressures from capital markets referred to earlier. The internal factors include pressures from the "costs/ benefits-oriented" evaluations of R&D projects by internal financial directors and sections. The stronger internal financial considerations may lead to R&D short-termism.

The internal pressures may be related to industrial market structure which is emphasized by industrial organization economics. There may be directors' orientation toward the "quiet life" which induces R&D short-termism, in particular in a highly-concentrated industry: Directors and managers who operate in such a monopolistic industry tend to reduce risks and seek a "quieter

life" than those who find themselves in a more competitive environment. But, Houlder[1996] suggests that in recent years both intensified competition and shorter product life cycle provide for R&D managers the pressures which do not allow them to focus on long-termism. The test of the quiet life hypothesis is an important, but unsolved problem in industrial economics.

The third question is what importance do you attach to the following factors ; (1) the reduction of the amount of time taken to get a product to the market, (2) the improvement of co-ordination between research, development, production and marketing, and (3) the need to obtain 'synergies' across divisions (Questions 5(1)～(3)). The respondents attach a greater importance to the first two factors. Therefore, the "intra-organizational relations and coordinations" are important for formulating and promoting R&D strategies. The perception may reflect the new trends such as "technology fusions" (like mechatronics and telematics), "system products" and the "networkings of products". These trends are likely to force companies to emphasize the coordinations among functional units or divisions within a company.

However, both the technological and the administrative respondents subgroups might not understand the content of the third statement and in particular the word "synergies" in the statement sufficiently.

Fourth, there is scarcely difference between both the subgroups in the view of top management's involvement in R&D strategy. As the results in Table 7-T suggest, top management actively involve in the "R&D-budget-setting process" (Question 6(1)) and, in particular in the "strategic planning of R&D" (Question 6(2)). Thus, top management often take leadership in R&D strategy-makings, or have a larger influence.

5 Organizational Structure of R&D

The results for the organizational structure of R&D are shown in Tables 11-T and 11-A. Also, some of the organizational implications are discussed earlier.

A little more than half (98 firms. 56 percent) of 175 technological respondents said that their companies had a "central R&D laboratory" (Question 11(5)). Also, a similar ratio (*i.e.*, 53 percent) was shown from the administrative responses. After all, 132 (*i.e.*, 55 percent) out of 239 sample firms have a central laboratory(11).

But, all of the work of the central laboratories is not accounted for by operations related to the divisions in a company (The results are not shown in the tables here). In the technological responses, companies of which the ratio for internal divisions is less than 50 percent account for 49 percent (*i.e.*, 45 firms) of 92 firms (6 respondents out of 98 firms had no reply), and companies with the ratio of 50 to 75 percent account for 36 percent (*i.e.*, 33 firms) of 92

firms. In the administrative responses, the ratio of the counterparts is 52 percent (=31/60) and 25 percent (=15/60) respectively. The combined ratio of the latter is a little smaller than the total ratio of the former. Therefore, the central laboratories often undertake R&D for their own works like basic research, which are beyond the scope of a division.

Second, as referred to earlier, Japanese large firms have a relatively small extent of overseas R&D operations, though expanding the operations in recent years (See Section III.2. Also see Doi[1994, 1996]). The extent may be related to the magnitude of overseas manufacturing operations. The overseas R&D operations of Japanese firms often aim to have access to foreign markets and technologies.

Finally, a given ratio of profits originated in a particular division may be allocated to the division as a fund for R&D. Respondents were asked about whether their companies operate a fund paid for centrally or by levy on divisions which is allocated to speculative R&D (Question 10(6)). As shown in the tables, such system is adopted by only 25 percent (24 firms) of 96 technological responses (= 98 firms less 2 firms with no reply), and also by only 19 percent (12 firms) of 63 administrative respondents. Therefore, in Japan there are only a small number of firms which adopt the "back payment" system of profits as a source of R&D fund. The result may be related to the fact that multi-divisional systems in Japan are of a "midway" type between functional and multi-divisional systems observed in the US and UK.

6 Determinants of R&D Budgets

R&D budget may be determined by some factors. Respondents were asked to rate each of the following 8 possible determinants of the size of R&D budget: (1) budget, (2) sales and (3) profits in a previous year, and (4) detailed costing/evaluation of projects in hand, (5) company-wide cash limit, (6) company objectives for growth, market share, etc, (7) activities of competitors, and (8) other (Questions 7(1)～(8)). The results for the questions are shown in Tables 8-T and 8-A.

《Table 8-T》

《Table 8-A》

Unexpectedly, although they attached to each factor an above-medium level of importance, there is no remarkable common rating, since it was often "scale 3" (*i.e.*, medium importance) that received the largest number of mentions as a determinant of R&D budjet. But, both the subgroups argue that the "company objectives" like growth and market share are important. Also, it is worth noting that more of the respondents selected the ratings of "scale 3 and 4" for the "activities of competitors". This finding is consistent with the above-

mentioned results for Question 2(12). Therefore, rivals' behavior is important for formulating strategies, but does not always have a dominant influence.

Further, it is worth noting that on the contrary the "detailed costing/ evaluation of projects" is of a relatively small importance for the technological responses. But the administrative responses provide a higher rating for the determinant. The difference also may be due to the variation in their responsibility; administrative directors and managers are likely to be more "costs-conscious" or "costs/benefits-conscious" than technological counterparts are.

7 Evaluation of R&D Projects

The next problem is concerned with the evaluation of R&D projects. Respondents were asked to rate each of the eight criteria in evaluating R&D projects: (1) payback, (2) return on capital investment, (3) added value, (4) fit to existing activities, (5) originality, creativity and innovation, (6) increased market share, (7) discounted cash flows, and (8) other (Questions 8(1) ~(8)). Tables 9-T and 9-A show the results for the questions.

《Table 9-T》

《Table 9-A》

The technological responses emphasized the six criteria except the "discounted cash flows" and "other". The administrative respondents have a similar pattern, as well. But, the latter place a relatively small importance on the "fit to existing activities", compared with the technological responses. The results for the "discounted cash flows" may be in part because the respondents might not understand the term sufficiently.

Next, turn to some institutional features of R&D budjets. The results are shown in Tables 10-T and 10-A, and also Tables 11-T and 11-A. Both the technological and administrative responses show a quite similar pattern. First, in more than half of respondents, their companies do not adopt the system or provision that divisions and business units within a company apply the headquarter for funding for the key R&D projects (Question 10(7). Tables 11-T and 11-A). Second, budjet targets are greatly important for R&D managers (Question 9(1). Tables 10-T and 10-A). And finally, a great number of Japanese firms do not operate the "performance bonus" system for R&D managers (Question 10(8). Tables 11-T and 11-A). The result may reflect that team-workings or group-workings are prevalent in Japan.

《Table 10-T》

《Table 10-A》

8 Patent Applications: Utilization of New Inventions

The final question here is concerned with technological appropriability. New inventions are frequently applied for patents or utility models (Doi[1994]). Also, as there is an increasing shift toward economic globalization, international patent applications are expected to increase. We asked respondents about the propensity to patent their new inventions (Question 12), and the importance of international patent applications (Question 10(9)). The results for the questions are shown in Tables 11-T and 12-T and Tables 11-A and 12-A.

〈Table 11-T ～ 12-T〉

〈Table 11-A ～ 12-A〉

The result is rather puzzling, since there were only a little more than half (*i.e.*, 53.1 percent) of technological respondents that replied that their companies applied nearly all of new inventions for patents. Also, over half of administrative respondents suggest that many of the new inventions have not been applied for patents.

In general, it is said that fierce patent application races take place in Japan. The race may force companies to apply most of newly-invented technologies for patents to gain competitive advantages. But, the present finding suggests that in spite of the fierce race, all of the new inventions may not be applied for patents. The unpatented part of new inventions are applied for utility models, or are strategically utilized as secrecy. Also, in place of patent protection, firms market some of new inventions as the first mover to establish an advantage over rivals.

However, the present finding is not necessarily incompatible with fierce patent application races, since new inventions include both major and minor ones, and a smaller number of technologically- or strategically- major inventions may be applied for patents. Also, it is because many of new processes are frequently utilized with no patent application. Finally, we should bear in mind that the finding may reflect the difference in perception or definition of "new inventions" among the respondents.

Thus, the propensity to patent varies across firm. These results may imply that if many major inventions are not applied for patents, then there is a qualification for patent count as a proxy for R&D performance. It is necessary to examine the determinants and quality of patent applications and patents granted.

However, according to the results from Question 10(9), when firms apply for patent protections, they attach a crucial importance to international patent applications. In fact, as suggested earlier, the presence of Japanese firms in patents granted in the US and the EU is increasing rapidly (see Doi[1994, 1996]).

XI Concluding Remarks

This paper has provided the univariate distributions of responses for various questions. We believe that the findings here portray a picture of R&D strategy-makings among Japanese large firms, or of the Japanese system of firm R&D and innovation. Some major features from the questionnaire survey are summarized as follows;

(1) Japanese large firms undertake R&D activity relatively independently of capital market pressures; they have a larger perceived independence. This finding conforms with the management independence of Japanese large firms which is suggested by previous studies.

(2) Firms have a somewhat stronger preference for product innovation than for process innovation.

(3) Scientists and engineers feel doubtful of the short-termism (like R&D strategy-makings based largely on their financial contributions) which may arise internally in a firm.

(4) Emphasis in the sourcing of new technologies is on in-house development and joint R&D ventures with customers and suppliers. In particular, many large firms undertake joint research with small- and medium-sized firms. But, there are a small number of companies which have overseas R&D operations.

(5) R&D is largely marketing-driven. R&D activity is conducted within the framework of a seamless decision-making process from R&D to maketing. Also, firms are concerned with rivals' behavior captured by R&D expenditures-sales ratio, but the influences of rivals' pressures on the determinations of R&D expenditures may not be overwhelming.

(6) Firms tend to focus on a limited number of R&D projects. Flexible R&D teams are frequently organized, which include many staffs involved in vertical operations from R&D to marketing.

(7) Corporate structure is important for R&D strategy-makings. Also, the majority of respondents think that scientists and engineers should join the board of directors, at least equally to the number of non-technological directors.

(8) Although, in Japan, a fierce patent application race is said to take place, large firms do not apply all of the new inventions for patent. But firms place much importance on international patent applications.

(9) Japanese style of architecture may be important for conducting R&D; team-workings of R&D organizations, intra-firm coordinations, and cooperative relationships with suppliers and customers.

(10) There are some differences in the responses for some questions between

the technological and administrative respondents. First, perceived independence is a little larger for the latter than for the former; Second, in the evaluations of R&D projects, the former prefer a technological performance-oriented test to a cost/benefits-oriented test, while the latter prefer a financial performance-oriented test to a technology-oriented test.

As Pavitt[1994] emphasizes, "we have no satisfactory theory of the large innovative firms" (p.357). The present empirical research may help to delineate the major characteristics of R&D activities in large firms, and in particular Japanese firms, which in turn are likely to lead to the theoretical development of large innovative firms.

However, there remain some problems to be examined. First, the results, as suggested earlier, may not capture finance directors' opinions sufficiently. Second, the findings here may be closely interwoven. But, the study did not examine the relationships between the results for various questions, and in particular between the extent of perceived independence from capital markets and the characteristics of results for other questions. In addition, not analyzed were the relationships of the characteristics derived from the questionnaire to the quantifiable factors like R&D measures, financial performance and overseas operations, and further their relationships to market structure of industries firms (and respondents) inhabit. Finally, the economic analyses of R&D institutions are necessary. The examinations of these problems are left to additional papers.

Note

* Professor of Economics, Department of Economics, Kwansei Gakuin University, Nishinomiya, 662 Japan.

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(1) For example, Acs and Audretsch[1990] and Geroski[1994] are very interesting empirical studies. Also, the various problems are excellently surveyed in Cohen[1995], Cohen and Levin[1989], Dodgson and Rothwell[1994], Scherer and Ross[1990] and Stoneman[1995].

(2) For a review of Japanese R&D, see for example Arrison *et al.*[1992], Lastres [1994], Mansfield[1988a, b, c] and Westney[1994].

(3) The factors affecting firm R&D and innovations are summarized by for example Pavitt[1994] and Rothwell[1994]. Also see Houlder[1995b] and Kay[1993].

(4) According to Doi[1994], the largest 300 R&D performers account for 74 percent of the economy total of R&D expenditures, and the largest 400 firms occupy 76 percent.

(5) Japanese corporate staffs are usually prudent in presenting their own views on their companies. For the interesting findings on directors' behavior in Japan, see *Nikkei Industrial Newspaper*, December 28, 1994 (in Japanese).

(6) Short-termism may arise when "too much emphasis is placed on short-term profit, which is detrimental to R&D and investment, and hence to long-term growth" (Nickell[1995, p.22]. With permission); Management have a higher discount rate than they would otherwise. For the short-termism debate, see for example Dimsdale and Prevezer[1994], Houlder[1996] and Nickell[1995].

(7) Joint research may include both joint ventures with domestic firms and with overseas firms. The latter type of joint venture is an important problem. See for example Takagi[1994].

(8) There is no consensus in the definition of small- and medium-sized enterprises (SMEs) among economists or policy makers. We followed the definition by official statistics: The official statistics defines SMEs in manufacturing as firms, either with less than 300 employees or with less than 100 million yen of equity capital. The definition is smaller in Japan than in the US and Europe (*i.e.*, firms with less than 500 employees). See Cowling and Doi[1995].

(9) There is difference in accounting for R&D expenditures between Japan and the US. In Japan, some of the expenditures in a particular year are counted as "current costs" in the statement of profit and loss (P/L statement) in the year, and the remaining part is capitalized as assets in the balance sheet. On the other hand, in the US all of the expenditures are counted as current costs in the P/L statement.

This difference may have an influence on R&D expenditures strategies; It is sometimes argued that Japanese firms can maintain the expenditures during a recession by allocating more of the expenditures to capitalization and concomitantly reducing current costs, while in the US, reducing the expenditures is a technique for maintaining profits (Thurow[1992, pp.141-2]).

But, in recent years Japanese large firms tend to prefer the "charge of R&D expenditures to expense". Therefore, the influence of accounting system may not be dominant.

(10) In our interviews, some respondents suggested that the planning period of

R&D projects tended to become shorter, because of competition.

(11)The second wave of the "central labo boom" has taken place since the late 1980s, which reflects an increasing importance of basic research and restructuring.

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Figure 1 A Framework for R&D Strategy Analysis

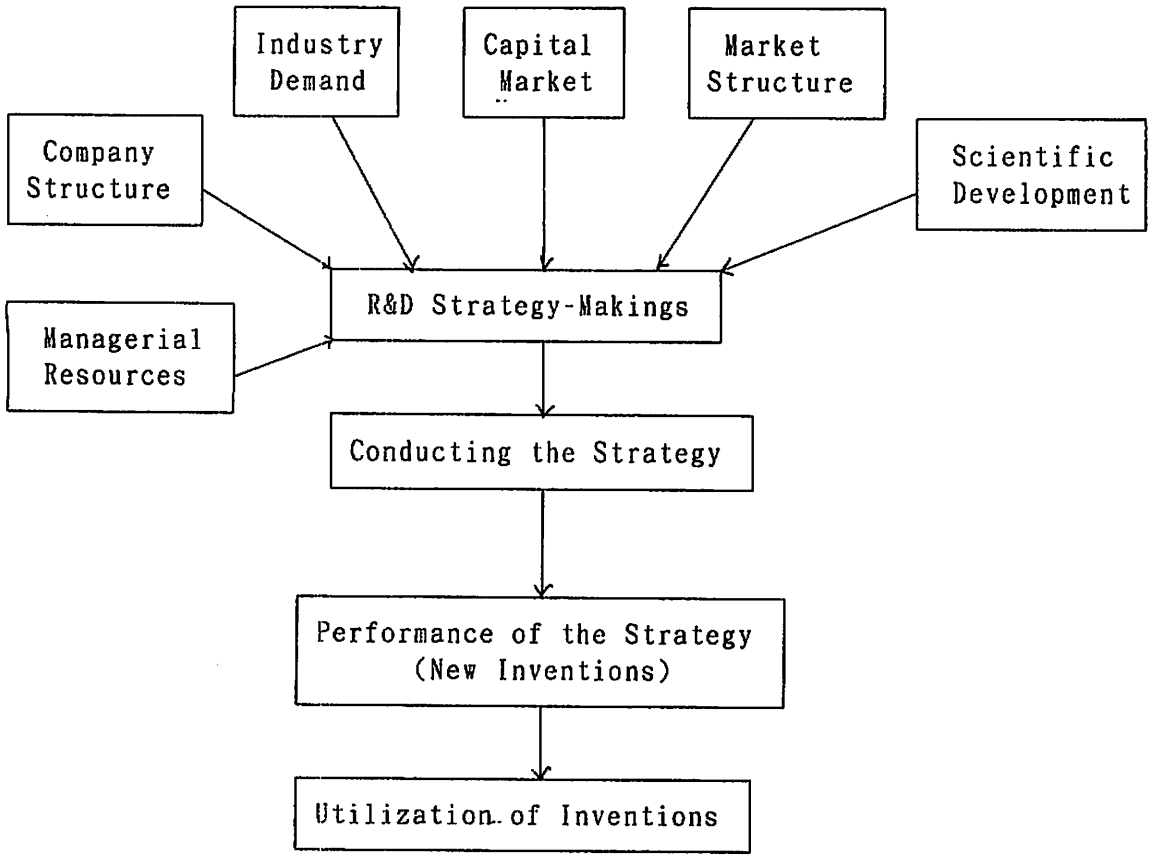

Table 2-T Pressures from Capital Markets

CAPITAL MARKET PRESSURES (Question 1(1)-(8))	Frequency					Total	Mean
	Disagree strongly	Disagree	Neither	Agree	Agree strongly		
Please give your opinion of the following statements	1	2	3	4	5		
1 It is difficult to provide profit figures which satisfy shareholders whilst funding R&D projects which are right for the business	59 (33.3)	77 (43.5)	22 (12.4)	16 (9.0)	3 (1.7)	177 (100.0)	2.023
2 We frequently experience pressures for short term profit maximization from our owners and therefore sometimes cancel projects which ought to be undertaken in the long-term interest of the company	76 (42.9)	74 (41.8)	12 (6.8)	8 (4.5)	7 (4.0)	177 (100.0)	1.847
3 Analysts and major shareholders are able to make decisions based upon adequate, technically informed analysis of the quality and value of R&D undertaken	26 (14.7)	77 (43.5)	54 (30.5)	18 (10.2)	2 (1.1)	177 (100.0)	2.395
4 Analysts and major shareholders often exhibit a strong bias against high-risk, long-term research in favor of low-risk, short-term product development	45 (25.4)	65 (36.7)	38 (21.5)	25 (14.1)	4 (2.3)	177 (100.0)	2.311
5 My company is perceived as being a possible candidate for take-over and this exacerbates the problem of pressures to deliver short-term R&D at the expense of long-term R&D	142 (80.2)	29 (16.4)	5 (2.8)	0 (0.0)	1 (0.6)	177 (100.0)	1.243
6 My company pays little regard to the opinion of financial market as we generate sufficient cash to finance all our requirements and we do not feel vulnerable to take-over	25 (14.1)	53 (29.9)	55 (31.1)	30 (16.9)	14 (7.9)	177 (100.0)	2.745
7 Shareholders today are better informed than they were ten years ago	7 (4.0)	18 (10.2)	72 (40.7)	65 (36.7)	15 (8.5)	177 (100.0)	3.356
8 Shareholders today demand more information than they did ten years ago	1 (0.6)	6 (3.4)	62 (35.0)	94 (53.1)	13 (7.3)	177 (100.0)	3.616

Table 2-A Pressures from Capital Markets

CAPITAL MARKET PRESSURES (Question 1(1)-(8))	Frequency					Total	Mean
	Disagree strongly	Disagree	Neither	Agree	Agree strongly		
Please give your opinion of the following statements	1	2	3	4	5		
1 It is difficult to provide profit figures which satisfy shareholders whilst funding R&D projects which are right for the business	41 (34.2)	58 (48.3)	14 (11.7)	6 (5.0)	1 (0.8)	120 (100.0)	1.900
2 We frequently experience pressures for short term profit maximization from our owners and therefore sometimes cancel projects which ought to be undertaken in the long-term interest of the company	53 (44.2)	56 (46.7)	6 (5.0)	5 (4.2)	0 (0.0)	120 (100.0)	1.692
3 Analysts and major shareholders are able to make decisions based upon adequate, technically informed analysis of the quality and value of R&D undertaken	16 (13.3)	45 (37.5)	40 (33.3)	18 (15.0)	1 (0.8)	120 (100.0)	2.525
4 Analysts and major shareholders often exhibit a strong bias against high-risk, long-term research in favor of low-risk, short-term product development	29 (24.2)	51 (42.5)	32 (26.7)	8 (6.7)	0 (0.0)	120 (100.0)	2.158
5 My company is perceived as being a possible candidate for take-over and this exacerbates the problem of pressures to deliver short-term R&D at the expense of long-term R&D	101 (84.2)	15 (12.5)	3 (2.5)	0 (0.0)	1 (0.8)	120 (100.0)	1.208
6 My company pays little regard to the opinion of financial market as we generate sufficient cash to finance all our requirements and we do not feel vulnerable to take-over	31 (25.8)	36 (30.3)	26 (21.7)	24 (20.0)	3 (2.5)	120 (100.0)	2.433
7 Shareholders today are better informed than they were ten years ago	0 (0.0)	11 (9.2)	38 (31.9)	63 (52.9)	7 (5.9)	119 (100.0)	3.555
8 Shareholders today demand more information than they did ten years ago	0 (0.0)	3 (2.5)	31 (26.1)	61 (51.3)	24 (20.2)	119 (100.0)	3.891

Table 3-T Strategic Emphasis

STRATEGIC EMPHASIS (Question 2(1)-(13))	Frequency					Total	Mean
	Very little	Little	Neither	Much	Very Much		
To what extent do the following statements apply to your company ?	1	2	3	4	5		
1 We are in a mature industry in which the emphasis is on production costs rather than product innovation	17 (9.7)	64 (36.4)	34 (19.3)	52 (29.5)	9 (5.1)	176 (100.0)	2.841
2 We are in a mature industry in which the emphasis is on product innovation rather than production costs	12 (6.9)	39 (22.3)	46 (26.3)	62 (35.4)	16 (9.1)	175 (100.0)	3.177
3 Relatively to our main competitors, we lean toward competition on cost rather than competition on product innovation	14 (8.0)	65 (37.1)	63 (36.0)	32 (18.3)	1 (0.6)	175 (100.0)	2.663
4 Research in our industry is more marketing-driven than science-driven	1 (0.6)	25 (14.3)	59 (33.7)	85 (48.6)	5 (2.9)	175 (100.0)	3.389
5 In our business, process innovation is more important than product innovation	11 (6.4)	55 (32.0)	73 (42.4)	28 (16.3)	5 (2.9)	172 (100.0)	2.773
6 Relative to our main competitors, we are marketing-driven rather than science-driven	3 (1.8)	19 (11.1)	32 (18.7)	101 (59.1)	16 (9.4)	171 (100.0)	3.632
7 Our emphasis in innovation is on adapting best practice elsewhere rather than developing in-house	35 (20.5)	78 (45.6)	39 (22.8)	19 (11.1)	0 (0.0)	171 (100.0)	2.246
8 Partnerships with customers in R&D are crucial to competitive success in our industry	4 (2.4)	7 (4.1)	17 (10.0)	96 (56.5)	46 (27.1)	170 (100.0)	4.018
9 Partnerships with suppliers in R&D are crucial to competitive success in our industry	7 (4.1)	30 (17.4)	41 (23.8)	79 (45.9)	15 (8.7)	172 (100.0)	3.378
10 It is highly important to focus on a limited range of projects organized around a few core competences drawn up within the framework of a clear technology strategy	1 (0.6)	5 (2.9)	32 (18.6)	99 (57.6)	35 (20.3)	172 (100.0)	3.942
11 R&D is an overhead which like any other costs has to be trimmed back during a recession	20 (11.6)	67 (39.0)	43 (25.0)	39 (22.7)	3 (1.7)	172 (100.0)	2.640
12 We always attempt to match or improve our competitors' R&D as % of sales.	48 (28.2)	83 (48.8)	34 (20.0)	5 (2.9)	0 (0.0)	170 (100.0)	1.976
13 Innovation through organic growth is more effective than innovation through acquisition	1 (0.6)	6 (3.6)	41 (24.3)	87 (51.5)	34 (20.1)	169 (100.0)	3.870

Table 3-A Strategic Emphasis

STRATEGIC EMPHASIS (Question 2(1)-(13))	Frequency					Total	Mean
	Very little	Little	Neither	Much	Very Much		
To what extent do the following statements apply to your company ?	1	2	3	4	5		
1 We are in a mature industry in which the emphasis is on production costs rather than product innovation	16 (13.6)	36 (30.5)	35 (29.7)	26 (22.0)	5 (4.2)	118 (100.0)	2.729
2 We are in a mature industry in which the emphasis is on product innovation rather than production costs	6 (5.1)	20 (16.9)	42 (35.6)	39 (33.1)	11 (9.3)	118 (100.0)	3.246
3 Relatively to our main competitors, we lean toward competition on cost rather than competition on product innovation	10 (8.5)	42 (35.6)	43 (36.4)	21 (17.8)	2 (1.7)	118 (100.0)	2.686
4 Research in our industry is more marketing-driven than science-driven	3 (2.5)	24 (20.2)	51 (42.9)	37 (31.1)	4 (3.4)	119 (100.0)	3.126
5 In our business, process innovation is more important than product innovation	7 (5.9)	40 (33.6)	53 (44.5)	19 (20.0)	0 (0.0)	119 (100.0)	2.706
6 Relative to our main competitors, we are marketing-driven rather than science-driven	3 (2.5)	13 (10.9)	29 (24.4)	67 (56.3)	7 (5.9)	119 (100.0)	3.521
7 Our emphasis in innovation is on adapting best practice elsewhere rather than developing in-house	21 (17.5)	69 (57.5)	17 (14.2)	12 (10.0)	1 (0.8)	120 (100.0)	2.192
8 Partnerships with customers in R&D are crucial to competitive success in our industry	3 (2.5)	7 (5.9)	20 (16.8)	65 (54.6)	24 (20.2)	119 (100.0)	3.840
9 Partnerships with suppliers in R&D are crucial to competitive success in our industry	1 (0.8)	16 (13.3)	35 (29.2)	59 (49.2)	9 (7.5)	120 (100.0)	3.492
10 It is highly important to focus on a limited range of projects organized around a few core competences drawn up within the framework of a clear technology strategy	1 (0.8)	8 (6.7)	36 (30.3)	61 (51.3)	13 (10.9)	119 (100.0)	3.647
11 R&D is an overhead which like any other costs has to be trimmed back during a recession	14 (11.7)	48 (40.0)	42 (35.0)	15 (12.5)	1 (0.8)	120 (100.0)	2.508
12 We always attempt to match or improve our competitors' R&D as % of sales.	41 (34.2)	57 (47.5)	19 (15.8)	2 (1.7)	1 (0.8)	120 (100.0)	1.875
13 Innovation through organic growth is more effective than innovation through acquisition	3 (2.5)	4 (3.3)	55 (45.8)	45 (37.5)	13 (10.8)	120 (100.0)	3.508

Table 4-T Development Sources for New Product

DEVELOPMENT SOURCE (Question 3(1)-(5))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
What do you consider the most important sources for the development of new products?	1	2	3	4	5		
1 In-house R&D	0 (0.0)	0 (0.0)	2 (1.2)	28 (16.6)	139 (82.2)	169 (100.0)	4.811
2 Joint Venture	1 (0.5)	6 (3.6)	25 (14.8)	103 (60.9)	34 (20.1)	169 (100.0)	3.959
3 Acquisitions	15 (8.9)	49 (29.0)	89 (52.7)	14 (8.3)	2 (1.2)	169 (100.0)	2.639
4 Licensing	0 (0.0)	11 (6.5)	50 (29.6)	99 (58.6)	9 (5.3)	169 (100.0)	3.627
5 Other	-	-	-	-	-	-	-

Table 4-A Development Sources for New Product

DEVELOPMENT SOURCE (Question 3(1)-(5))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
What do you consider the most important sources for the development of new products?	1	2	3	4	5		
1 In-house R&D	0 (0.0)	0 (0.0)	1 (0.8)	17 (14.4)	100 (84.7)	118 (100.0)	4.839
2 Joint Venture	2 (1.7)	5 (4.2)	17 (14.3)	60 (50.4)	35 (29.4)	119 (100.0)	4.017
3 Acquisitions	8 (6.8)	21 (17.8)	54 (45.8)	32 (27.1)	3 (2.5)	118 (100.0)	3.008
4 Licensing	2 (1.7)	7 (5.9)	31 (26.3)	62 (52.5)	16 (13.6)	118 (100.0)	3.703
5 Other	-	-	-	-	-	-	-

Table 5-T Strategic Planning and Company Structure

STRATEGIC PLANNING (Question 4(1)-(5))	Frequency					Total	Mean
	Disagree strongly	Disagree	Neither	Agree	Agree strongly		
To what extent do you agree with the following statements ?	1	2	3	4	5		
1. It is often necessary to sacrifice potential sysnergy between divisions to provide the motivation and improved inter-functional co-ordination that goes with devoted strategic responsibility	11 (9.1)	28 (23.1)	56 (46.3)	25 (20.7)	1 (0.8)	121 (100.0)	2.810
2 It is sometimes difficult to get central initiatives under way in a decentralized structure	4 (3.3)	32 (26.0)	38 (30.9)	45 (36.6)	4 (3.3)	123 (100.0)	3.106
3 If strategic planning of R&D is reduced to purely financial equations, then it fails	2 (1.6)	12 (9.8)	18 (14.8)	70 (57.4)	20 (16.4)	122 (100.0)	3.770
4 R&D in this company needs to be more centralized	7 (5.7))	33 (26.8)	42 (34.1)	37 (30.1)	4 (3.3)	123 (100.0)	2.983
5 It is necessary to adopt structure which protect long-term research agaist the pressures of shorter-term applied research and product development	2 (1.6)	18 (14.6)	30 (24.4)	50 (40.6)	23 (18.7)	123 (100.0)	3.602

Table 5-A Strategic Planning and Company Structure

STRATEGIC PLANNING (Question 4(1)-(5))	Frequency					Total	Mean
	Disagree strongly	Disagree	Neither	Agree	Agree strongly		
To what extent do you agree with the following statements ?	1	2	3	4	5		
1. It is often necessary to sacrifice potential sysnergy between divisions to provide the motivation and improved inter-functional co-ordination that goes with devoted strategic responsibility	6 (9.7)	22 (35.5)	23 (37.1)	11 (17.7)	0 (0.0)	62 (100.0)	2.629
2 It is sometimes difficult to get central initiatives under way in a decentralized structure	2 (3.0)	23 (34.8)	18 (27.3)	22 (33.3)	1 (1.5)	66 (100.0)	2.955
3 If strategic planning of R&D is reduced to purely financial equations, then it fails	3 (4.5)	9 (13.6)	18 (27.3)	28 (42.4)	8 (12.1)	66 (100.0)	3.439
4 R&D in this company needs to be more centralized	1 (1.5)	26 (38.8)	20 (29.9)	18 (26.9)	2 (3.0)	67 (100.0)	2.910
5 It is necessary to adopt structure which protect long-term research agaist the pressures of shorter-term applied research and product development	4 (6.0)	12 (17.9)	20 (29.9)	28 (41.8)	3 (4.5)	67 (100.0)	3.209

Table 6-T Importance in Planning

STRATEGIC PLANNING (Question 5(1)-(3))	Frequency					Total	Mean
	Low importance		Medium		High importance		
What importance do you currently attach to:	1	2	3	4	5		
1 The reduction of the amount of time taken to get a product to the market ?	6 (3.5)	13 (7.5)	18 (10.4)	57 (32.9)	79 (45.7)	173 (100.0)	4.098
2 The improvement of co-ordination between research, development, production and marketing	3 (1.7)	6 (3.5)	20 (11.6)	71 (41.0)	73 (42.2)	173 (100.0)	4.185
3 The need to obtain synergies across divisions ?	8 (4.8)	17 (10.3)	58 (35.2)	58 (35.2)	24 (14.5)	165 (100.0)	3.442

Table 6-A Importance in Planning

STRATEGIC PLANNING (Question 5(1)-(3))	Frequency					Total	Mean
	Low importance		Medium		High importance		
What importance do you currently attach to:	1	2	3	4	5		
1 The reduction of the amount of time taken to get a product to the market ?	2 (1.8)	3 (2.7)	14 (12.4)	30 (26.5)	64 (56.6)	113 (100.0)	4.336
2 The improvement of co-ordination between research, development, production and marketing	0 (0.0)	4 (3.6)	12 (10.7)	44 (39.3)	52 (46.4)	112 (100.0)	4.286
3 The need to obtain synergies across divisions ?	3 (2.8)	11 (10.3)	37 (34.6)	33 (30.8)	23 (21.5)	107 (100.0)	3.579

Table 7-T Management Involvement in Strategy-Makings

STRATEGIC PLANNING (Question 6(1)-(2))	Frequency					Total	Mean
	No inter-vention		Medium		Active partici-pation		
How would you rate top management's involvement in:	1	2	3	4	5		
1 The R&D budget-setting process	2 (1.1)	22 (12.6)	52 (29.9)	59 (33.9)	39 (22.4)	174 (100.0)	3.638
2 The strategic planning of R&D	1 (0.6)	11 (6.3)	30 (17.2)	69 (39.7)	63 (36.2)	174 (100.0)	4.046

Table 7-A Management Involvement in Strategy-Makings

STRATEGIC PLANNING (Question 6(1)-(2))	Frequency					Total	Mean
	No inter-vention		Medium		Active partici-pation		
How would you rate top management's involvement in:	1	2	3	4	5		
1 The R&D budget-setting process	5 (4.4)	12 (10.6)	23 (20.4)	44 (38.9)	29 (25.7)	113 (100.0)	3.708
2 The strategic planning of R&D	0 (0.0)	4 (3.5)	15 (13.0)	26 (22.6)	70 (60.9)	115 (100.0)	4.409

Table 8-T Determinants of the R&D Budget

CONTROL MECHANISM (Question 7(1)-(8))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
Rate each of the following as determinants of the size of the R&D budget	1	2	3	4	5		
1 Last year's budget	5 (2.9)	17 (9.8)	67 (38.5)	60 (34.5)	25 (14.4)	174 (100.0)	3.477
2 Last year's sales	6 (3.5)	32 (18.6)	60 (34.9)	60 (34.9)	14 (8.1)	172 (100.0)	3.256
3 Last year's profits	6 (3.5)	20 (11.6)	59 (34.1)	58 (33.5)	30 (17.3)	173 (100.0)	3.497
4 Detailed costing/evaluation of projects in mind	14 (8.1)	47 (27.2)	61 (35.3)	46 (26.6)	5 (2.9)	173 (100.0)	2.890
5 Company-wide cash limits	10 (5.8)	27 (15.6)	55 (31.8)	57 (32.9)	24 (13.9)	173 (100.0)	3.335
6 Company objectives for growth, market share etc	2 (1.1)	12 (6.9)	41 (23.6)	87 (50.0)	32 (18.4)	174 (100.0)	3.776
7 Activities of competitors	6 (3.5)	21 (12.4)	76 (44.7)	48 (28.2)	19 (11.2)	170 (100.0)	3.312
8 Other			-	-	-	-	-

Table 8-A Determinants of the R&D Budget

CONTROL MECHANISM (Question 7(1)-(8))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
Rate each of the following as determinants of the size of the R&D budget	1	2	3	4	5		
1 Last year's budget	3 (2.8)	7 (6.4)	45 (41.3)	50 (45.9)	4 (3.7)	109 (100.0)	3.413
2 Last year's sales	17 (15.5)	23 (20.9)	42 (38.2)	26 (23.6)	2 (1.8)	110 (100.0)	2.755
3 Last year's profits	6 (5.5)	19 (17.4)	41 (37.6)	39 (35.8)	4 (3.7)	109 (100.0)	3.147
4 Detailed costing/evaluation of projects in mind	5 (4.6)	19 (17.4)	31 (28.4)	43 (39.4)	11 (10.1)	109 (100.0)	3.330
5 Company-wide cash limits	5 (4.5)	17 (15.5)	41 (37.3)	39 (35.5)	8 (7.3)	110 (100.0)	3.255
6 Company objectives for growth, market share etc	1 (0.9)	1 (0.9)	15 (13.9)	59 (54.6)	32 (29.6)	108 (100.0)	4.111
7 Activities of competitors	3 (2.8)	12 (11.0)	39 (35.8)	45 (41.3)	10 (9.2)	109 (100.0)	3.431
8 Other	-	-	-	-	-	-	-

Table 9-T Evaluation of R&D Projects

· CONTROL MECHANISM (Question 8(1)-(8))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
How much importance does your compay attach to each of the following criteria in evaluating R&D projects:	1	2	3	4	5		
1 Payback	1 (0.6)	0 (0.0)	27 (15.5)	79 (45.4)	67 (38.5)	174 (100.0)	4.213
2 Return on capital investment	0 (0.0)	3 (1.7)	33 (19.0)	89 (51.1)	49 (28.2)	174 (100.0)	4.057
3 Added value	1 (0.6)	3 (1.7)	38 (22.1)	96 (55.8)	34 (19.8)	172 (100.0)	3.924
4 Fit to existing activities	0 (0.0)	8 (4.6)	45 (26.0)	98 (56.6)	22 (12.7)	173 (100.0)	3.775
5 Originality, creativity and innovation	0 (0.0)	5 (2.9)	27 (15.5)	78 (44.8)	64 (36.8)	174 (100.0)	4.115
6 Increased market share	1 (0.6)	7 (4.1)	26 (15.3)	86 (50.6)	50 (29.4)	170 (100.0)	4.041
7 Discounted cash flows	7 (4.4)	30 (18.9)	76 (47.8)	40 (25.2)	6 (3.8)	159 (100.0)	3.050
8 Other	-	-	-	-	-	-	-

Table 9-A Evaluation of R&D Projects

CONTROL MECHANISM (Question 8(1)-(8))	Frequency					Total	Mean
	Of no importance		Medium		Crucial		
How much importance does your compay attach to each of the following criteria in evaluating R&D projects:	1	2	3	4	5		
1 Payback	0 (0.0)	3 (2.8)	19 (17.6)	56 (51.9)	30 (27.8)	108 (100.0)	4.046
2 Return on capital investment	0 (0.0)	2 (1.8)	17 (15.6)	58 (53.2)	32 (29.4)	109 (100.0)	4.101
3 Added value	0 (0.0)	2 (1.9)	30 (27.8)	53 (49.1)	23 (21.3)	108 (100.0)	3.898
4 Fit to existing activities	2 (1.9)	9 (8.3)	40 (37.0)	47 (43.5)	10 (9.3)	108 (100.0)	3.500
5 Originality, creativity and innovation	0 (0.0)	1 (0.9)	19 (17.4)	45 (41.3)	44 (40.4)	109 (100.0)	4.211
6 Increased market share	0 (0.0)	4 (3.8)	23 (21.7)	43 (40.6)	36 (34.0)	106 (100.0)	4.047
7 Discounted cash flows	0 (0.0)	16 (15.4)	52 (50.0)	29 (27.9)	7 (6.7)	104 (100.0)	3.260
8 Other	-	-	-	-	-	-	-

Table 10-T Budget Targeting

CONTROL MECHANISM (Question 9(1))	Frequency					Total	Mean
	Unimportance		Medium		Crucial		
	1	2	3	4	5		
1 How important are budget targets for R&D project managers	0 (0.0)	3 (1.7)	47 (26.6)	71 (40.1)	56 (31.6)	177 (100.0)	4.017

Table 10-A Budget Targeting

CONTROL MECHANISM (Question 9(1))	Frequency					Total	Mean
	Unimportance		Medium		Crucial		
	1	2	3	4	5		
1 How important are budget targets for R&D project managers	1 (0.9)	5 (4.5)	24 (21.4)	53 (47.3)	29 (25.9)	112 (100.0)	3.929

Table 11-T The Results for the Yes/No Type Questions

	QUESTIONS (Question 10(1)-(9))	YES	NO	TOTAL
1	Does your company employ somebody at a senior level with full-time responsibility for investor relations?	90 (52.6)	81 (47.6)	171 (100.0)
2	Do you think that joint research has contributed to profitability and growth of your company for ten years?	108 (61.7)	67 (38.3)	175 (100.0)
3	Is your company undertaking joint research with small- and medium-sized firms?	90 (53.6)	78 (46.4)	168 (100.0)
4	Does your company have overseas R&D operations?	67 (39.4)	103 (60.6)	170 (100.0)
5	Is there a central R&D laboratory which works for the group as a whole?	98 (56.0)	77 (44.0)	175 (100.0)
6	Does your company operate a fund paid for centrally or by levy on divisions which is allocated to speculative R&D?	24 (25.0)	72 (75.0)	96 (100.0)
7	Do division and business units within your company have provision to apply 4 to the headquarter for funding for key R&D projects?	73 (42.9)	97 (57.1)	170 (100.0)
8	Does your company operate performance bonuses for R&D managers?	28 (16.2)	145 (83.8)	173 (100.0)
9	Is emphasis for patents on international applications as well as domestic applications?	168 (96.0)	7 (4.0)	175 (100.0)

Table 11-A The Results for the Yes/No Type Questions

	QUESTIONS (Question 10(1)-(9))	YES	NO	TOTAL
1	Does your company employ somebody at a senior level with full-time responsibility for investor relations?	67 (56.3)	52 (43.7)	119 (100.0)
2	Do you think that joint research has contributed to profitability and growth of your company for ten years?	66 (55.5)	53 (44.5)	119 (100.0)
3	Is your company undertaking joint research with small- and medium-sized firms?	50 (42.0)	69 (58.0)	119 (100.0)
4	Does your company have overseas R&D operations?	46 (38.7)	73 (61.3)	119 (100.0)
5	Is there a central R&D laboratory which works for the group as a whole?	63 (56.3)	49 (43.7)	112 (100.0)
6	Does your company operate a fund paid for centrally or by levy on divisions which is allocated to speculative R&D?	12 (19.0)	51 (81.0)	63 (100.0)
7	Do division and business units within your company have provision to apply 4 to the headquarter for funding for key R&D projects?	29 (26.4)	81 (73.6)	110 (100.0)
8	Does your company operate performance bonuses for R&D managers?	9 (8.0)	103 (92.0)	112 (100.0)
9	Is emphasis for patents on international applications as well as domestic applications?	108 (94.7)	6 (5.3)	114 (100.0)

Table 12-T The Results for the Other Questions

QUESTION (Question 11)	Yes	No	About the same	Total
Should scientists and engineers outnumber persons with accounting and legal qualifications in the board?	23 (41.8)	7 (12.7)	25 (45.5)	55 (100.0)
QUESTION (Question 12)	**Nearly all**	**Over half**	**Under half**	**Total**
What percentage of your new inventions are applied for patents?	93 (53.1)	26 (14.9)	56 (32.0)	175 (100.0)

Table 12-A The Results for the Other Questions

QUESTION (Question 11)	Yes	No	About the same	Total
Should scientists and engineers outnumber persons with accounting and legal qualifications in the board?	8 (24.1)	4 (12.1)	21 (63.6)	33 (100.0)
QUESTION (Question 12)	**Nearly all**	**Over half**	**Under half**	**Total**
What percentage of your new inventions are applied for patents?	50 (44.2)	16 (14.2)	47 (41.6)	113 (100.0)