Division of Research
School of Business Administration

October 1987

R&D SPENDING, DOMESTIC COMPETITION, AND EXPORT PERFORMANCE OF JAPANESE MANUFACTURING FIRMS

Working Paper #530

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R&D Spending, Domestic Competition, and Export Performance of Japanese Manufacturing Firms

This paper examines three factors influencing the export performance of Japanese manufacturing firms: R&D spending, domestic competitive position, and firm size. R&D expenditures and the size of a firm, and the average R&D intensity of an industry are positively associated with export sales. A firm's export ratio is related to the industry R&D ratio, but not to the firm's R&D ratio. Follower firms are characterized by higher export intensity than market leaders. The results indicate a relationship between the patterns of domestic competition and the international competitiveness of Japanese firms.

Many observers have cited the ability of Japanese manufacturing firms to capitalize on their strength in the domestic market as the foundation of their international competitive strategies. The achievement of economies of scale, as well as relentless quality improvement and cost reduction programs, targeted first at domestic customers, enabled many Japanese firms to penetrate foreign markets with a large volume of low-cost but high-quality standardized products, and then move to higher value-added niches (Abegglen & Stalk, 1985; and Kotler, Fahey, & Jatusripitak, 1985). Yet, despite the abundance of qualitative descriptions of the Japanese export drive, little has been done in terms of rigorous analysis.

The international competitiveness of a firm is reflected in the amount of its export activities. In an open market, an increase in competitiveness leads to an increase in exports. A better understanding of factors influencing exports would enhance our knowledge of factors influencing international competitiveness. Traditionally, such analyses were focused on macroeconomic variables, such as factor endowment and their relative prices, exchange rates, and trade policies (Denison and Chung, 1976; and Saxonhouse, 1982). However, in this study, we examine the relations of exports to firm and industry-level variables. We propose that these measurements of export performance are related to the amount of R&D expenditures, firm R&D intensity, industry R&D intensity, firm size, and market position.

In the first section of our paper, we will present the conceptual foundations for our examination of export performance in Japanese manufacturing firms and the related hypotheses. In the next section we will introduce our model and its variables and describe the data we use. The statistical analysis is presented in the third section, followed by a discussion of results. Implications for the international competitive

strategies of Japanese manufacturing firms and directions for future research are suggested in the last section.

HYPOTHESES

The decision to examine the impact of corporate R&D policies is not accidental. Technological innovation is clearly at the core of business strategy for Japanese firms today (Imai, Nonaka, & Takeuchi, 1985; and Takeuchi & Nonaka, 1986). Traditionally, Japanese firms have pursued technological innovation through the purchase of necessary technology from overseas (Ozawa, 1974; and Peck, 1976). However, in many industries, Japanese firms have reached the technological level of their foreign competitors and thus there are fewer opportunities for them to continue technological imports (Sakakura, 1984). As a result, Japanese firms are relying less and less on licensing from overseas, and more and more on their internal research efforts (Odagiri, 1983). Recently, Campbell (1985) emphasized the importance of technical innovation at all levels in the manufacturing chain for competitive rivalry in Japan.

Despite the shortcomings of the measure (Link & Neufeld, 1986), the amount of R&D expenditures is a commonly used indicator of the technological innovation efforts of a firm (Uno, 1984). Pioneer research was done by Tsurumi (1972) who showed a link between export performance and R&D factors of Japanese manufacturers on the industry level. The focus on R&D expenditures as a factor in the export performance of Japanese firms also parallels the basic reasoning in the works of Odagiri (1983) and Franko (1985). These studies analyzed links between R&D intensity and related royalty payments and a firm's profitability and growth rates. However, profitability and growth

rates may not be good measures of international competitiveness. It is quite possible that some firms, while successful in domestic markets, may not be able to transfer their domestic market advantages into foreign markets (e.g. brand name recognition, distribution network).

In contrast, following Tschoegl (1983) and Hirsh & Bijaoui (1985), we focus on the relationship between R&D expenditures and export sales. We propose that, because Japanese firms perceive R&D expenditures as a base of competitive advantage (Kotler, et al., 1985), the level of R&D expenditures is associated with increased penetration of export markets. The relationship between export performance and R&D expenditures can be a two-way interaction. A R&D effort aimed at the international markets may lead a better export performance, or a better export performance may create resources to fund additional R&D programs.

Parry and Watson (1979) analyzed data of the foreign subsidiaries in Australia and found that there was a positive and significant relationship between the firms' R&D expenditures and export ratio. Keesing (1967) analyzed U.S. data and concluded that high R&D intensity industries tend to export more than low R&D intensity industries. We apply a similar relationship to Japanese data on the firm level. Thus, controlling for the size of a firm, we should observe:

H1: positive relationship between export sales and the amount of R&D expenditures.

H2: positive relationship between export ratio and the R&D intensity.

H3: positive relationship between export sales and the industry R&D intensity.

H4: positive relationship between export ratio and the industry R&D intensity.

The export sales of a firm are also affected by its domestic competitive position. Many writers argue that the domestic competition among Japanese firms is very keen (Abegglen & Stalk, 1985; Inoue, 1985; Ohmae, 1981; and Pucik, 1986), and that a scramble for market share rather than short-term profits by Japanese firms is one of the factors which encourage surges of exports (Borrus and Zysman, 1986). But again, there are few published papers which empirically analyze the relationship between domestic market position and international competitiveness on the firm level. Studies focusing on the impact of market position in Japan are usually concerned with overall profitability, not export performance (e.g. Tanaka & Doi, 1985), as is much of the literature on market structure and company performance in the West (e.g. Caves, 1982).

Several writers cited above noted that many Japanese firms with high export visibility are not market leaders in Japan. For example, in 1983, Toyota's export percentage (46.2%) was less than those of Nissan (55.2%) and Honda (68.6%); Matsushita's export percentage (34.1%) was less than those of Sony (65.6%) and Sanyo (58.1%).

A proposition can be put forward that companies which have established a leading market share within Japan (leader), may have a lower export intensity than their competitors (followers). The domestic leaders' competitive advantage comes from a variety of sources, such as lower cost, better products and services, faster innovation, strong distribution channels, organizational flexibility, financial strength, and aggressive strategy. The difference between the leaders and the followers in the domestic market springs from the total strength of the sustainable competitive advantage: the followers lack one or some of the competencies which the leaders have. However, the Japanese

market leaders may not have sustainable competitive advantage in international markets over their domestic followers, assuming that firms in both categories can supply internationally competitive products, while the incremental benefit derived from exports may be higher for the latter.

Based on this logic, one would expect that the follower firms, looking for growth opportunities, would put more emphasis on exports due to the fact that it may be very difficult for them to expand their domestic market share. It appears that the relatively static domestic distribution network in Japan is one of the most important competitive weapons available to leading firms (Okamoto, 1979). The only way the followers can circumvent the leader is by going abroad in the same fashion as firms domiciled in markets of relatively small size (Luostarinen, 1980).

If the proposition concerning leader/follower impact on export performance is correct, we expect to observe:

H5: negative association between exports and leadership position, after controlling for size.

H6: higher export intensity among the follower firms relative to leaders.

Finally, in terms of the effect of firm size alone, the direction of the relationship has been shown to be fairly straightforward. In previous studies Auquirer (1980), who analyzed French firms, and Hirsh & Adar (1974), who analyzed Danish, Dutch, and Israeli firms, asserted that increased size leads to increased exports as the larger the firm, the higher its ability to search the world for new business opportunities. We propose that the same relationship is valid for firms in Japan. Thus we expect:

H7: positive association of exports with company size.

Other factors often mentioned as a source of Japan's international competitiveness, such as the country's financial system, cost of capital, exchange rate and general wage levels, affect most firms in an industry and across industries in fairly similar ways. We do not at this point look at the environmental factors such as the industrial policy of the Japanese government. By 1983 (the year for which we collected data), government support of exports was concentrated primarily in the area of R&D promotion, a variable already included in our investigation (The Comptroller General of the United States, 1982; and Ozaki, 1984).

MODEL AND DATA

We test three basic models in our analysis. In the first model, the export sales is regressed on R&D expenditures, size of the firm, market position, and industry R&D intensity variables. To provide a contrast with the results obtained through the first equation, we will also test an alternative model substituting domestic sales for exports. And finally, the export intensity of a firm is regressed on R&D intensity, size of the firm, market position, and the industry R&D instensity.

The first cross-sectional model examines the relationship between export sales (variable EXPORT) and R&D expenditures (R&D) as moderated by the asset size of the firm (ASSETS), and its market position (LEADER) (Hypotheses H1, H5, and H7). Inclusion of the industry R&D intensity (INDR&D) makes it possible to control industry characteristics, such as the speed of technological innovation, the importance of R&D activities, etc. (Hypothesis

H3). Thus, we can ascertain how one unit of expenditure in R&D in a firm is related to export sales across industries.

To highlight the impact of the independent variables on exports, we estimate a parallel equation with export sales replaced as dependent variable by domestic sales (DOMESTIC). A detailed description of all variables is presented in APPENDIX 1. It should be emphasized that in the first two models we examine the absolute values of both export sales and R&D expenditures. The potential influence of size is controlled by its inclusion in the regression model.

We employ ordinary least squares regression to test the relationship between export sales, R&D expenditures, asset size, market leadership, and industry R&D intensity. Application of the logarithmic transformation below permits testing for increasing or decreasing returns to independent variables. The first model is:

$$\widehat{\text{Log(EXPORT)}} = \hat{B}_{01} + \hat{B}_{11}\,\text{Log(R\&D)} + \hat{B}_{21}\,\text{Log(ASSETS)} + \hat{B}_{31}\,\text{LEADER} + \hat{B}_{41}\,\text{Log(INDR\&D)} \qquad (1)$$

For example, the parameter $\hat{B}_{11}$ represents the percent change in EXPORT for a one percent change in R&D, accounting for the effects of the firm size (ASSETS), and the industry R&D intensity (INDR&D), i.e. this formulation permits us to investigate the elasticity of exports with respect to R&D.

We also include a dummy variable (LEADER) to analyze whether the industry leader's export behavior is different from smaller firms. A LEADER is identified on the basis of a firm's relative size in an industry. The industry categories are taken from MITI's classification (see APPENDIX 1). Data which differentiate business unit exports and firm exports are to our

knowledge not made public, so in the case of a diversified company, each is classified into the industry of its largest segment of business. However, in our example, only firms in four industries (shipbuilding, textile machinery, chemical fertilizer, and photographic equipment) are widely diversified (less than 50% of sales in a single industry). In addition, diversification patterns are fairly similar within industries. For example, in shipbuilding industry, many firms diversified into machine tools, steel fabrication, oil drilling rigs, etc. In general Japanese companies tend to have a narrower range of business interests and thus tend to be less diversified in comparison with Western firms (Clark, 1979). Although the industry classification used is far from perfect, we believe that it is appropriate, and the best available.

Our second regression enables us to investigate the elasticity of domestic sales with respect to R&D with the same explanatory variables above.

$$\widehat{\text{Log(DOMESTIC)}} = \hat{B}_{02} + \hat{B}_{12}\,\text{Log(R\&D)} + \hat{B}_{22}\,\text{Log(ASSETS)} + \hat{B}_{32}\,\text{LEADER} + \hat{B}_{42}\,\text{Log(INDR\&D)} \qquad (2)$$

For both variants of the model, the expected signs of the coefficients are positive for all variables but $\hat{B}_{31}$, which is negative.

In the third model, we focus on relative measures of export performance, such as export and R&D percentages of sales (e.g. Odagiri, 1983; and Hirsh & Bijaoui, 1985), and estimate the relationship between export ratio (EXPORT%) and R&D ratio (R&D%), industry average R&D ratio (INDR&D), size of the firm (ASSETS), and market position (LEADER) to test Hypotheses H2, H4, and H6.

$$\widehat{\text{EXPORT\%}} = \hat{B}_{03} + \hat{B}_{13}\ \text{R\&D\%} + \hat{B}_{23}\ \text{Log(ASSETS)} + \hat{B}_{33}\ \text{LEADER} + \hat{B}_{43}\ \text{INDR\&D} \quad (3)$$

The expected signs of the coefficients are significant and positive for all variables but $\hat{B}_{33}$, which is negative. However, we are concerned that such measures by themselves are not always appropriate for samples drawn across industries, each with different R&D intensity. Therefore, as in the first two models, the influence of the industry difference is controlled by the inclusion of the average R&D intensity of each industry.

The sample for the first three models is 271 Japanese manufacturing firms in 40 industries listed at the Tokyo, Osaka, and Nagoya Stock Exchanges with capitalization of over one billion yen and that reported export sales in 1983[1]. The actual figures were obtained from the Ministry of International Trade and Industry (1985), Nikkei Kaisha Joho (1984), and Statistics Bureau, Management and Coordination Agency, Japan (1985). The year 1983 was chosen because it is the first year for which reliable R&D data on the firm level are publicly available.

The most complete Japanese corporate R&D data are compiled by the Statistics Bureau, Management and Coordination Agency, but they are published on the industry level only. Another frequently used source is the NEEDS data base which contains same data from Nikkei Kaisha Joho (1984). Griliches and Mairesse (1985) found the early NEEDs data unreliable in their R&D coverage: for example, Toyota, Nissan, Honda, and Hitachi did not report positive R&D expenditures in the NEEDS data base in 1981 survey. However, by 1983, this deficiency had largely been corrected, at least for the larger corporations that are the subject of our analysis.

ANALYSIS AND DISCUSSION

TABLE 1 is a correlation matrix of the 1983 data of the first three models. There are no independent variables with a higher squared correlation than the R2 from the regressions of models (1), (2), and (3). After standardizing the variables, we obtained the models' condition indices which are a statistical test for multicollinearity; the condition index for each model, of which the highest value was 4.728, suggested that multicollinearity was not a problem (Belsley, Kuh, & Welsch, 1980).

TABLE 2 shows the regression results of the exports (1), domestic sales (2), and export ratio models (3). Because we chose to take the logarithmic values of EXPORT, DOMESTIC, R&D, ASSETS, and INDR&D, we dropped some cases which report zero values on exports and R&D expenditures. To ensure that our results were not dependent on these cases, we examined the model twice after adding 0.01 and 0.001 to each element of each vector. The results were the same in both cases.

The first regression results show that the coefficients of R&D, ASSETS, and INDR&D are significant but that of LEADER is not significant at $p<.05$. The coefficient of LEADER is significant at $p<.10$. Hypotheses H1, H3, and H7 receive significant support; hypothesis H5 is supported marginally.

The two R&D related variables have a distinct and strong role in shaping the export performance of Japanese manufacturing firms. In contrast to Franko's (1985) findings that the relative R&D, not the absolute amount of R&D matters to the corporate performance of Japanese firms, our data show that the absolute levels of R&D expenditures of Japanese manufacturing firms have a significant association with exports. The elasticity of exports with respect to R&D is less than 1. On average, a 1% increase in R&D expenditure is

associated with a 0.15% increase in exports. The difference in the outcome of the analysis may be attributed to our focus on exports, rather than on the overall corporate growth percentage rates.

As expected, the export intensity of an industry (INDR&D) shows a positive ralationship with exports. The higher the R&D intensity of an industry, the higher the export sales of firms within the industry. This corresponds to results obtained for the U.S. economy by Keesing (1967). In both cases, a need for a heavy R&D commitment may force firms to look beyond domestic markets to recapture their investments. An alternative explanation that a heavy export orientation causes R&D ratios to rise, while logically plausible in the context of our model, runs counter the evidence from the earlier studies of exports and the product life cycle (Vernon, 1966; and Mckenna, Borrus, and Cohen, 1984).

Also, in accordance with our hypothesis, the position of industry market leader is negatively linked with the level of exports. We proposed that this may be due to a lack of distinct international competitive advantage associated with leadership in a domestic market. At least two alternative explanations can also account for this result: for industry leaders, the risk-adjusted returns are better in the domestic market where the leader has already built competitive advantages in finance, marketing, etc.; or, domestic competitive advantage can be more profitably leveraged through horizontal or vertical differentiation than through exports.

Finally, the exports of Japanese firms rise in proportion to their assets base. The elasticity of exports with respect to assets is slightly more than 1. On average, a 1% change in assets is associated with about a 1% change in exports. This result may be seen as paradoxical in light of the contrary impact of market leadership. It suggests that what matters is the asset size

of the firm per se, not its relative market position againt its domestic competitors.

The second regression in TABLE 2 shows that when domestic sales are substituted for export sales as the dependent variable, all variables but LEADER are significant at $p<.01$ level. LEADER is significant at $p<.05$ level. As in the case of exports, R&D expenditures on the firm level exert a significant and positive influence on domestic sales. However, in sharp contrast to model (1), the signs of coefficients for LEADER and INDR&D is reversed. The positive and significant relationship between leadership position and domestic sales is as expected. The negative relationship between the domestic sales of a firm and a R&D intensity of the industry to which the firm belongs may be surprising, but it reinforces the earlier observation: Japanese high-tech industries are fundamentally export-oriented.

The elasticity of domestic sales with respect to assets is less than 1, substantially below that of export sales. The comparison of the two models indicates that under current economic conditions, new investment in "hard" assets is primarily export-oriented. The higher assets productivity in case of exports may also suggest that, on average, the economies of scale are designed to fit the domestic market and that many export sales may be in this respect incremental.

The third regression in TABLE 2 shows that contrary to our prediction, the R&D intensity of a firm does not have a significant relationship with EXPORT%. Only INDR&D and ASSETS have a significant and positive association with EXPORT%. An industry leader's position has a negative relationship with the export intensity. In other words, the export intensity of a firm is related to the R&D intensity of the industry to which the firm belongs, the size of its assets, and its market position, but it is not related to the R&D

intensity of the firm. We find a support for hypothesis H4, but hypothesis H2 should be rejected. This is true in spite of the fact that as model (1) shows, the absolute amount of R&D is related to the absolute amount of exports.

Generalizations from our findings are subject to several limitations. The reliability of the data is the first issue. For example, the definition of R&D expenditures in the Japanese accounting system is rather ambiguous. It may be that some firms inflate this figure to boost their "progressive" image. Also, the assets figures may not be entirely reliable. According to Kuroda and Oritani (1980), for several reasons, the asset base of many Japanese firms is often seriously understated, especially for older firms. If indeed the assets of Japanese firms are larger than reported, their relationship with export sales will be less than estimated in our model.

Second, the effect of R&D expenditures on export sales may be cumulative over time. Japanese firms have tended to invest almost exclusively in applied research (Johnson, 1984). The model presented is based on an assumption that current R&D expenditures are a reasonable approximation for past R&D efforts and that the R&D results will be materialized in the form of sales in a same year. This assumption should be tested in future research when a large sample of, say, t-5 years data is available. Such firm-level data are not yet publicly compiled. In addition, once sufficient historical data become available, the validity of model (1) should be tested in a longitudinal design.

Third, although the explanatory power of the first two models is relatively high, some variables may have been excluded from the model that may have a significant effect on the international competitiveness of Japanese firms. For example, as pointed out earlier, foreign markets can be penetrated

through exports or through direct foreign investment. Thus, it may be that the export sales of some "leader" firms in the sample are depressed because of the substitution of investment for export sales. However, the value-added in foreign production by Japanese firms was not very high in 1983 (Kujawa, 1986), and in our data, EXPORT includes products and parts sales. In addition, company-level foreign direct investment data show a similar leader/follower exports pattern as we have shown for exports. For example, Honda (follower) has 79.3 billion yen foreign direct investments in total, in comparison with Toyota's (leader) 41.5 billion yen; and Toshiba (follower) has 73.3 billion yen in foreign direct investments against Hitachi's (leader) 17.1 billion yen (The Oriental Economist, 1984).

Finally, as pointed out earlier, because of the limitations of our data base, we have not made a distinction between business-unit export intensity and a firm export intensity. Theoretically, this could influence our examination of market leadership impact on export performance. A large corporation may operate in diversified businesses, whereas smaller companies generally tend to have a limited number of businesses. For example, Company A is a diversified leader in electronics which manufactures consumer electronics, industrial electronics and home appliances. Company A exports a high percentage of consumer electronics but a low percentage of industrial electronics and home appliances, yet these businesses are fairly large in its total output. Company B is a follower which manufactures only consumer electronics whose export intensity is high. If the two companies are classified into the same industry, the classification may not reveal the real export pattern of each firm's business. We believe that this is not a critical problem in our data base, because in 22 out of 40 industries, diversification ratios (sales of a diversified business over total sales) of

industry leaders are less than those for industry as a whole, and only 8 out of 40 leaders show diversification ratio over 50 percent. While the availability of business-level data would enhance our analysis, we estimate that at least 68% of all firms' sales are correctly identified by the present classification.

POLICY AND RESEARCH IMPLICATIONS

A strong export mentality in Japanese firms is documented by Ohmae (1982). There is no question about the importance of foreign markets to Japanese firms. While export-led growth has often been only one of the growth alternatives available to American firms (the U.S. domestic market has fewer entry barriers, unfriendly mergers and acquisitions are socially acceptable, etc.), many Japanese firms have no choice. In this context, the analysis presented here highlights some of the key factors behind the export performance of Japanese manufacturing firms.

Rather than focus on the traditional notion that Japanese firms borrow technology at American firms' expense (McKenna, Borrus, and Cohen, 1984), we tried to shed light on the consequences of technology creation by large Japanese firms. While we do not want to discount the impact of manufacturing efficiency and product quality on international competitiveness, it is clear that Japanese manufacturers are getting ready for the next stage of global competition where the competitive advantage will be based on technological rather than manufacturing superiority. The objective of R&D policies is to constantly renew and upgrade the existing technology and thus reinforce today's competitive advantage for tomorrow. Such a competitive advantage is probably less vulnerable to exchange rate fluctuations than strategies based

on cost advantages in materials or labor. If Japanese firms are indeed going "high-tech" in order to cement their international competitive position (Borrus and Holstein, 1987), then current exchange rate trends (stronger yen) are not going to provide much relief to their embattled foreign competitors. The strong R&D efforts and the resulting improvements in products and production process will likely make the Japanese even stronger international competitors.

Kotler, et al. (1985) recognized that there is a product orientation in Japanese firms; yet they claimed that Japanese firms seem to be more market- and customer-driven than product- and technology-driven. Our findings do not contradict their claims - the two orientations are often complementary - but illustrate the critical importance of a product- and technology-driven strategy for Japanese firms. The results also shed additional light on the aggressive pricing strategies that Japanese firms tend to use in foreign markets. The practice of setting a price deliberately low in foreign markets has been explained as a way to build up market share and establish a dominant position with lower profits in the short run, but with high profits in the long run (Jain, 1984: and Kotler, et al., 1985). The results here show that even in the short run, Japanese firms can be profitable with lower overseas prices because a unit increase of assets has a greater positive impact on exports than on domestic sales. Under such conditions, the decision in many Japanese firms to set export prices lower than the average domestic prices is quite rational, not withstanding the dismay of their foreign competitors.

We cannot say from our data whether or not Japanese industrial R&D is specifically targeted at international markets, but clearly that is where the pay-offs from R&D are, especially for the high R&D-spending industries. We agree with Campbell (1985) that domestic competition may be so severe that new

product introduction is essential just to stay even. Companies rapidly imitate each other's new products or launch them so quickly that R&D spending by itself cannot provide a sustainable competitive advantage domestically.

In other words, sales into the Japanese domestic market may be influenced by "inelastic" sources of competitive advantage, such as brand recognition, distribution channels, or supplier relations, etc. If this is the case, market-entry strategies based on technological advantage only may be of limited use to foreign newcomers. Sooner or later, Japanese firms will close the gap and eventually push back the intruders. Technological superiority in the Japanese market has to be viewed as a "window of opportunity" that has to be expanded into advantages in other areas in a relatively short period of time.

From a research perspective, several new directions seem especially promising. As pointed out above, R&D influence on export sales should be examined in a longitudinal fashion. With the increasing availability of firm-level data on R&D expenditure, it may be possible to concentrate investigation on a smaller number of industries, and thus eliminate or at least reduce biases inherent in cross-sectional sampling techniques. With the increased popularity of off-shore manufacturing in recent years, future analysis can also be enhanced by the inclusion of sales from overseas operations. Finally, several factors which may also affect the export performance of Japanese firms, e.g. industrial policy or industrial group affiliation (Okimoto, 1987), were not condidered in this analysis. Inclusion of such factors in the analysis of Japanese competitiveness may be another fruitful direction.

NOTES

1. The list of industries and corporations is available upon request.

TABLE 1

Correlation Matrix

Variable							
DOMESTIC	.695						
EXPORT%	.399	.084					
R&D	.846	.725	.264				
R&D%	.251	.159	.286	.459			
ASSETS	.789	.834	.245	.753	.205		
LEADER	.204	.406	.001	.302	.170	.316	
INDR&D	.246	.122	.357	.399	.639	.190	.162
	EXPORT	DOMESTIC	EXPORT%	R&D	R&D%	ASSETS	LEADER

TABLE 2

Regression Results of the Full Model in 1983

	For Log(EXPORT)	For Log(DOMESTIC)	For EXPORT%
Constant	-4.102	2.215	-36.343
	(-5.917)**	(6.758)**	(-3.594)**
Log(R&D)	0.154	0.183	---
	(2.031)*	(5.094)**	---
R&D%	---	---	0.633
	---	---	(0.874)
Log(ASSETS)	1.063	0.693	4.122
	(11.269)**	(15.538)**	(4.488)**
LEADER	-0.322	0.220	-9.218
	(-1.755)+	(2.535)*	(-2.795)**
Log(INDR&D)	0.391	-0.395	---
	(3.160)**	(-6.763)**	---
INDR&D	---	---	3.936
	---	---	(3.682)**
F-ratio	200.604**	456.504**	16.440**
R^2	0.751	0.873	0.198

(t-statistics in parentheses)

+p<.10

*p<.05

**p<.01

APPENDIX 1

EXPORT = Dependent variable. The export sales of a company in millions of yen in 1983.

EXPORT% = Dependent variable. (Export sales) / (Total sales) in percent.

DOMESTIC = The domestic sales of a company in millions of yen in 1983.

R&D = R&D spending of a company in millions of yen.

R&D% = (R&D) / (Total sales).

ASSETS = Total assets value of a company in millions of yen.

LEADER = Dummy variable. All manufacturing companies are categorized into industries based on Ministry of International Trade and Industries (1985). MITI adopts the Standard Industry Classification for Japan (JSIC), which is based on the United Nations' International Standard Industrial Classification, with some adjustments. If a company is a leading firm in an industry, it is assigned a 1; otherwise, it is assigned a 0.

INDR&D = Industry average R&D percentage compiled by Statistics Bureau, Management and Coordination Agency, Japan (1985).

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