Fast Growing Strategy of SMEs by Using R&D Networks[1]

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Abstract

This paper discusses fast growing strategy of SMEs focusing on R&D collaborations with other firms and universities. Due to the lack of managerial resources, paradoxically, the most important internal managerial ability of high growth SMEs is how to manage its external relationship in areas, where a firm cannot prepare by its own resources. It is found that high growth SMEs are conducting risky business by investing in R&D networking activities heavily, but we have found that they have to pass some transition period to become big. It is important for policy makers to distinguish firm's growth process into start-up period and transition one. Promotion of venture capital, IPR policy and other institutional reforms toward network innovation system is important for the former purpose, but the latter process is basically driven by market competition and evolutional selection process.

1. Introduction

A speed of firm's growth depends on various kinds of factors. In order to increase its revenue, it is important to expand its product line and marking channels. At the same time, continuous product/service developments and process engineering for production and/or service efficiency are critical to provide attractive products/services at reasonable prices. This process requires building up a firm's managerial resources, including human resources, tangible and intangible capitals. However, SMEs are relatively unpopular in job market, and creating its own technological capabilities, corporate brand, strong distribution channels, customer's royalty is a painful task for young and small unknown companies.

In this regards, using external resources is the most important strategy for fast growth of SMEs, where internal capacity building cannot be done easily. In a world of open

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innovation, modularization of product architecture, unbundling of industrial organization, division of innovative labor etc., it becomes easier for SMEs to grow rapidly by following network based business development strategy. Paradoxically, the most important internal managerial ability of high growth SMEs is how to manage its external relationship in areas, where a firm cannot prepare by its own resources.

This paper picks up a case of R&D network management as one of examples of external relationship managements. A next section looks at the data from the Basic Survey of Business Structure and Activities by METI to characterize high growth SMEs and the importance of R&D outsourcing for fast firm growth. Section 3 presents a trend of R&D networks and its impact on innovation activities by using RIETI's Survey on R&D Collaborations. Finally, this paper concludes with policy implications.

2. Importance of R&D network for fast growth

What is high growth SMEs (HGSMEs)? In this section, HGSMEs are identified by an average speed of firm's revenue from its starting year. We use the firm level data of BSBSA (Basic Survey of Business Structure and Activity by METI) in 2003 to identify HGSMEs. BSBSA is a firm level census survey for manufacturing and wholesale/retail industry with a threshold point of 50 employees and 30 million capital amount. We pick up only SMEs (according to Japanese definition, such as 300 or less employment for manufacturing) and independent firms in a sense of being not affiliated with other large companies.

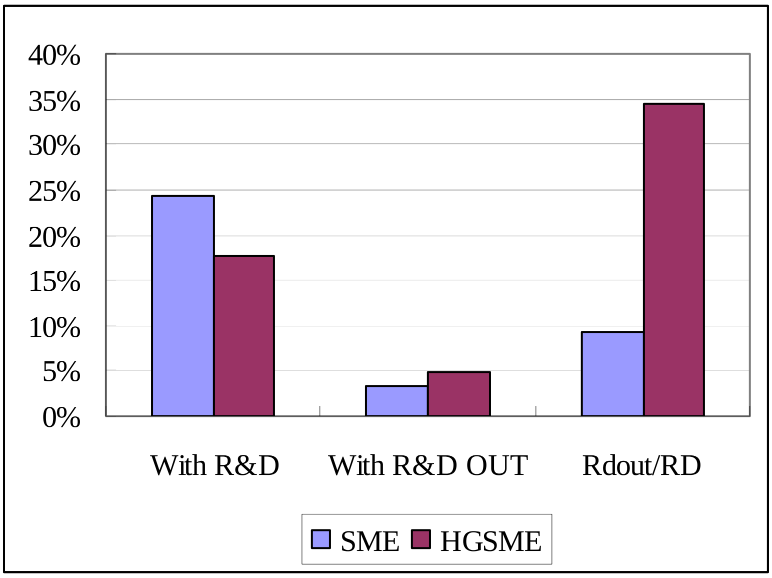
There are about 13,000 independent SMEs in our sample, and we define HGSMEs as top 5% firms in terms of an average growth rate of sales or employment. The cut-off growth rates for HGSME in this process turn out to be annual growth amount of 500 million yen revenue or 10 employees. In table 1, the number of firms and the share of HGSMEs in the category of revenue and employment growth by starting year are presented. It is natural to see the share of HGSMEs increase as a firm age becomes younger. However, it should be noted that there is some selection bias due to the existence of threshold point of survey such as 50 employees and more. In a category of younger age (such as started after 1991), a lot of firms under this threshold point should exist, but are not shown up in the survey results.

Table 1: The share of HGSMEs by starting year

	-1945	1946-1970	1971-1980	1981-1990	1991-
# of firms	1,226	8,351	2,179	1,322	555
500 mil/year	2.6%	2.6%	4.5%	8.9%	31.5%
10 emp/year	0.0%	0.0%	2.1%	15.1%	58.7%

Figure 1 shows the difference of R&D activities between HGSMEs and the other SMEs. The share of firms with R&D is larger for the other SMEs, while the share of firms with R&D outsourcing is larger for HGSMEs. Therefore, fast growing SMEs tend to use more R&D outsourcing. This can be confirmed by comparing the ratio of R&D outsourcing to in-house R&D between two groups. This ratio is 35% for HGSMEs while it is about 10% for the other SMEs. Innovation by internal R&D is important for firm's growth. However, setting up internal R&D staffs and facilities may be a time consuming task for SMEs, and it might be faster to find out an appropriate external organization to conduct R&D for its purpose.

Figure 1: Comparing R&D activities between HGSMEs and the other SMEs



Finally, we look at the distribution of log of R&D (absolute amount by 1 million JPY) and log of R&D outsourcing (Figure 2A and 2B) by age cohort. It is found that its size of R&D is larger for HGSMEs, when a firm is relatively young, while it is large for the other SMEs for older firms. The size of R&D decreases by firm age for the other firms, implying such firms increases R&D as it grows. In contrast, HGSMEs invest heavily in R&D when they are young. In contrast, the size of R&D outsourcing does not change very much across different age cohorts for the other SMEs. In a HGSME group, we can see again the same U shaped pattern as is found in the size of R&D distribution. These two graphs suggest that R&D strategy is quite different between these two groups in a sense that HGSMEs are conducting more risky business by investing in R&D and R&D outsourcing substantially.

Figure 2A: Distribution of log of R&D for HGSMEs and the other SMEs

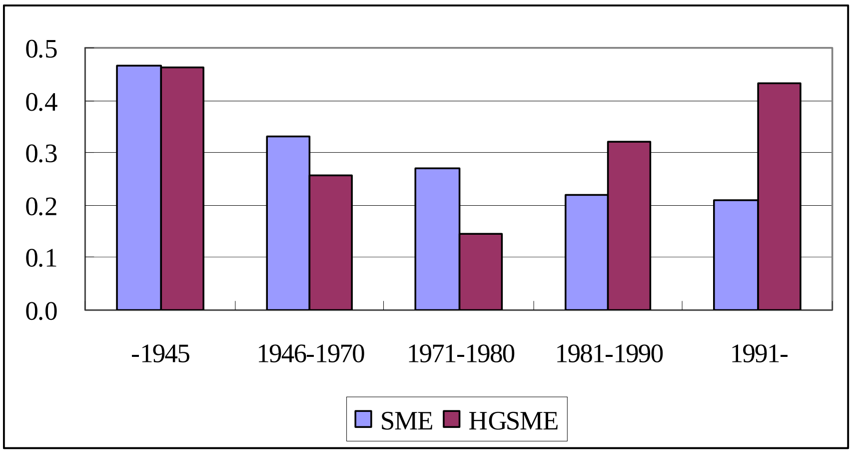
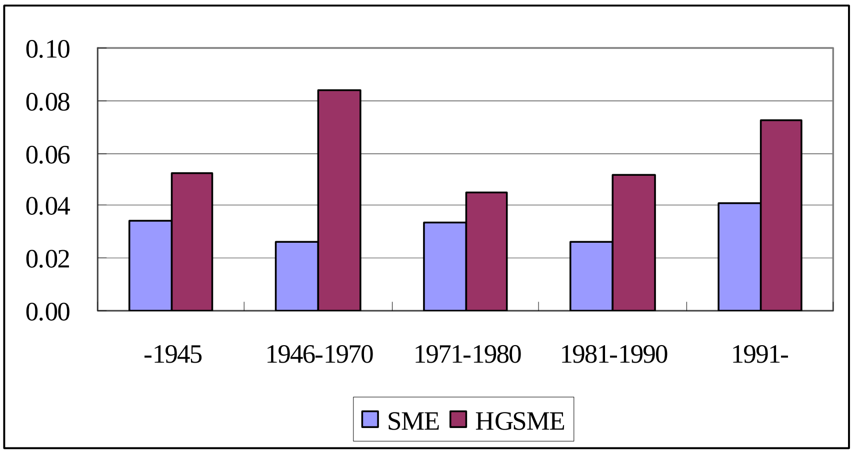


Figure 2B: Distribution of log of R&D outsourcing for HGSMEs and the other SMEs

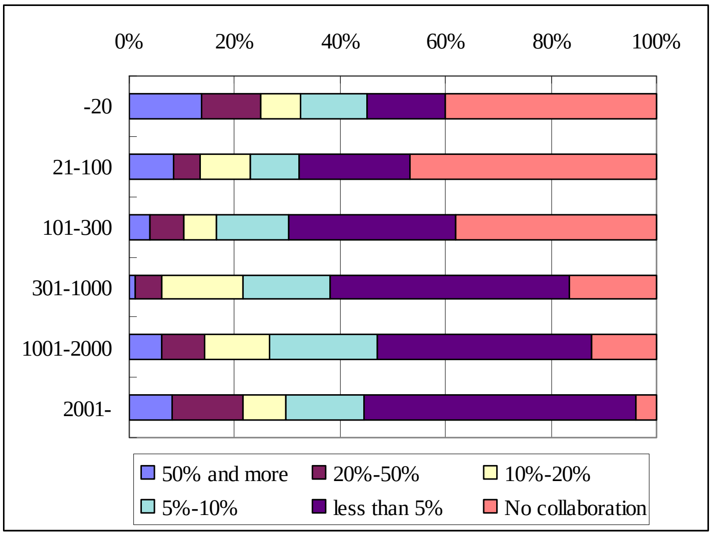


3. R&D collaboration and its impact on innovation

In order to investigate trend and activities of R&D collaborations, RIETI has conducted the Survey on R&D collaborations in 2004 (RIETI, 2004). It is found that more than 70% of the firms were engaged in some form of external collaboration with other firms, universities, or public research institutes. In this survey, current activities as well as the situation 5 years ago are asked, and the results show that collaborations with large corporations have increased from 31.2% to 37.5%, collaborations with small firms have increased from 22.2% to 38.7%, and collaborations with universities have increased from 39.7% to 51.3%, recording an increase in the ratio of external collaborations for all partners. These results reveal that the R&D process of Japan has been shifting from an in-house oriented system to network based one. Furthermore, out of the different types of partners, more than half of the companies participate with universities, and the ratio of firms collaborating with universities has increased most rapidly.

Let us now take a closer look at external collaborations with respect to firm size. Figure 3 shows the proportion of the firm's R&D collaborations with respect to the firm's total R&D (the share in the R&D budget) grouped by firm size. First, the larger the size of the firm, the higher is the proportion of firms engaging in some form of R&D collaboration. Approximately half of the small firms have not engaged in any form of external collaboration, while most of the firms with more than 2000 employees have engaged in such collaboration. On the contrary, when we look at trends in the proportion of R&D collaborations with respect to total R&D, the proportion is higher for smaller firms. For example, out of the firms with less than 20 employees, more than 20% of the firms have R&D collaboration ratios higher than 50%. The proportion of these firms declines until firms in the category with the number of employees between 301 and 1000 and then increases after this threshold, exhibiting a U-shaped pattern[3].

Figure 3: Share of outsourced R&D to total R&D by firm size



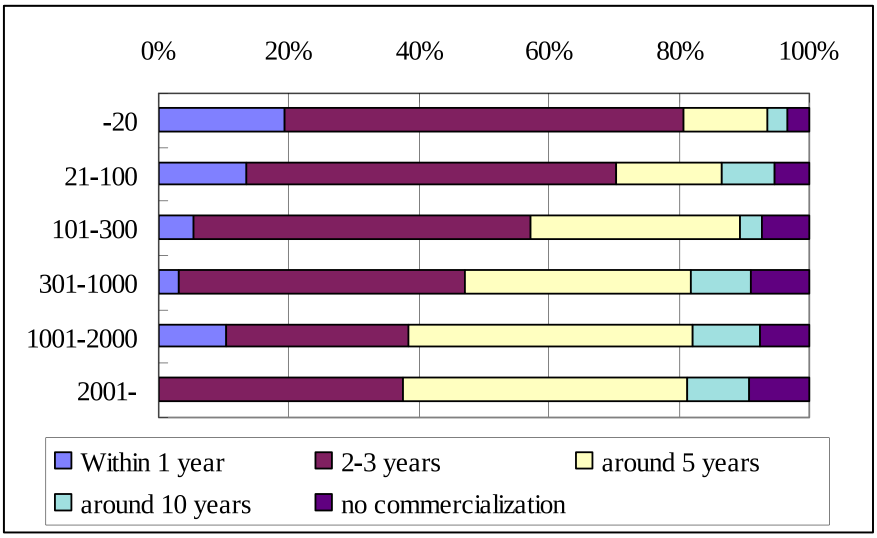
[3] This U-shape pattern does not result from biases from the distribution of firms based on industrial classifications or types of technology (For example, the majority of small firms are biotechnology or IT start-ups), but instead reflects a common characteristic observed across industries. For a closer examination of the sample size grouped by firm sizes and industrial classification, refer to RIETI (2004).

The smallest category of firms are mostly high-tech startup firms which do not possess sufficient resources to conduct in-house R&D, and this may be a reason to provide strong incentives for these firms to actively engage in R&D collaborations. On the other hand, it is said that additional in-house R&D is essential in order to make use of R&D collaborations instead of simply introducing the technology from external parties. If the technological capacity, or the absorptive capacity of the firm is critical as in the aforementioned case, it will be more effective for larger enterprises to conduct external collaborations (Cohen and Levinthal, 1990). The results of Figure 3 could be interpreted as results from both of these effects. Several studies have investigated the effects of UIC activities with respect to firm size, mainly in the U.S. For example, Cohen et al. (2002) have shown that large enterprises were more active in UICs than SMEs[4]. On the contrary, Acs et. Al (1994) showed that for innovation activities such as new product introductions, SMEs utilized the results of university research more effectively, while companies with poor in-house R&D resources tended to be more active in utilizing external resources. In Figue 3, both of these factors are shown up behind the U-shaped relationship between firm size and the intensity of R&D collaborations.

Here, we focus on the collaborations with university. This university industry collaboration (UIC) activity is particularly important for science based new technology firms such as biotech. In addition, we have already seen that the UIC involves quite heterogeneous activities from collaborative research to technology consultations (Motohashi, 2005a). In this regards, Figure 4 shows the difference of timeframe of UIC activities by firm size.

[4] The exceptions were medical-related start-ups (founded within 5 years and with number of employees less than 500), which actively took part in industry-academia collaborations.

Figure 4: Timing of commercialization by UIC



The proportion of firms targeting on relatively short term effects is high for small firms, while the proportion of responses indicating longer term merits increase with respect to firm size. For firms with less than 20 employees, close to 20% of the firms expect commercialization of products within 1 year, and over 80% of the firms expect such results within 2-3 years. These findings are consistent with the view that there is a strong need for SMEs to engage in external collaborations targeted at short term benefits due to its deficient R&D resources. Although it is often thought that UIC activities are conducted utilizing scientific knowledge created by universities which pursue fundamental research and that these activities typically focus on long run benefits, these findings indicate that this is not necessarily the case. Presumably, substantial number of firms in the smallest category is high-tech startups, which are a good candidate for HGSMEs after evolutional selection market selection process. In Motohashi (2008), quantitative analysis on the relationship between UIC and firm performance is presented. Here, the patent count is used as a proxy of innovation output, which is regressed by the following variables.

- lrd : Amount of R&D Investments(in logarithm)
- lemp : Firm size (logarithm of the number of employees)
- cord : Dummy variable for R&D collaborations
- lage : Firm Age (year: logarithm)
- lage2: Logarithm of firm age squared
- univ : Dummy variable for UICs 5 years ago
- industry dummies

Table 2 reports the results of the analysis using the number of patent applications in 2001 as the independent variable. First, Table 2 shows the results from the whole sample of the basic model with and without firm age (Model (2) and Model (1), respectively). Next the whole sample was divided into three groups based on age group, and the results for each of the groups are reported in Models(3)-(5).

First, in Model (1), the coefficient related to UICs is positive and statistically significant, implying that engagement in UICs has a positive impact on research productivity. This coefficient does not change much in the model including firm age. For firm age, we did not observe a statistically significant result for the analysis using only lage, and we included an additional term, lage squared, and obtained a statistically significant result for both of these coefficients. As the coefficients of these terms indicate, R&D productivity decreases with respect to the age of the firm, but after a certain threshold, increases once again, exhibiting a U-shaped pattern.

Table 2: University industry collaboration and research productivity

	all	all	-1950	1951-70	1971-
	(1)	(2)	(4)	(5)	(6)
lrd	0.276 (7.81)**	0.260 (7.19)**	0.434 (5.61)**	0.183 (3.05)**	0.109 (2.29)*
lemp	0.250 (6.08)**	0.246 (5.41)**	0.397 (3.72)**	0.315 (3.30)**	0.131 (2.84)**
cord	-0.030 (0.23)	-0.056 (0.45)	-0.131 (0.53)	0.146 (0.67)	-0.169 (1.06)
univ1	0.377 (3.21)**	0.355 (3.05)**	0.203 (0.95)	-0.077 (0.33)	0.348 (2.09)*
lage		-2.402 (4.81)**			
lage2		0.360 (4.86)**			
Constant	-1.683 (7.10)**	2.302 (2.57)*	-4.257 (8.51)**	-1.188 (2.83)**	0.439 (1.30)
Industry Dummies	yes	yes	yes	yes	yes
Observations	450	438	168	134	136
R-squared	0.62	0.64	0.77	0.55	0.49

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

In order to delve into the effects of firm age and UIC, Model(3) - Model(5) show the results by firm age group. The firms in Model(3) are the oldest group, followed by those in Model(4) and Model(5). Statistically significant coefficients are found only in Model

(5). This implies that young, relatively small firms have increased research productivity through UIC activities. As for the other group of firms, the result for Model (3) reports a positive coefficient although it is statistically insignificant, while Model (4) shows a negative coefficient.

Since SMEs are engaged in UIC activities that is closer to the final product stage such as the development of new products, these activities are likely to be more directly linked to the results of the development. In addition, since SMEs have a constraint on both financial and human management resources, they are more in a need to engage in UIC activities within a shorter time scope than large enterprises. Furthermore, SMEs face a more stringent constraint on management resources than large enterprises, implying a greater risk in engaging in UIC activities. Therefore, the firms that were able to overcome these risks may be receiving a greater return.

However, the marginal productivity of UIC does not monotonically decreases. We can find U shaped relationship, in a sense of the marginal productivity picks up in a group of old and established firms. It should be noted that this observation comes from cross sectional look, which does not always provide inter temporal observation for a particular firm's life. But, this finding suggests the existence of a kind of transition point between start up companies and established ones. How to overcome this process depends on the type of innovation and business. For example, it needs a long time for a pharmaceutical product to be launched in a market, so that an important strategy for biotech is how to ensure venture capital funding and to make most of out licensing of their drug candidates compounds. Start up businesses in software and internet business can get their products or service out to the market in shorter timeframe. But they have to face more volatile market due to rapid technological progress and fast moving market environment.

4. Policy Implications

Because SMEs lack R&D resources, they have a strong incentive to engage in R&D networks and university industry collaborations that leads to immediate results such as the development of a new product, overcoming the systematic impediments of networking. Universities also have some incentive to collaborate with SMEs, since joint projects with them tend to fulfill their desire of creating pragmatic products based on the results of fundamental research, in contrast to R&D collaborations with large enterprises that tend to prefer fundamental research projects. In a world open innovation, promoting UIC activities are beneficial not only for SMEs, which have a great incentive to apply network innovation model, but also for an overall society. This is particularly the case for Japan, since the Japanese innovation system is characterized as a large company centered in-house system. Moving toward network base system is imperative for sustaining technological competitiveness of Japan as a whole.

In order to reform Japanese innovation systems towards a network oriented one, there are some policies affecting institutional settings or framework conditions for innovation are needed. RIETI's Survey suggests that quite a number of firms listed "Intellectual property related problem" as an obstacle. Many of the enterprises expect licensing from foreign universities and enterprises to increase in the future, indicating firms' increasing awareness toward international disputes regarding patents. An active technology market with a stable system of intellectual property is a necessary condition to foster high-tech startup firms that lack the managerial resources to input in areas such as manufacturing and marketing (Hall and Ziednis, 2001).

In addition, the reforms of national universities and national research institutes have enabled these organizations to collaborate with enterprises at their own will. The system for stimulating SMEs in UIC activities and facilitating university spin-offs that uses the technologies of universities is improving. In addition, restructuring the capital market to enable seamless supply of risk money and fostering venture capital is a vital task. As a final note, in order to establish a societal system full of innovative activities through R&D collaborations between various parties, the mobility of human resources becomes crucial. The rigid system of personnel that is common in some enterprises or research institutes may become an obstacle for realizing effective collaborations amongst firms or between firms and universities. Increasing the mobility of human resources burgeons various, new career opportunities for researchers, which may result in attracting more stars, stimulating the system of innovation as a whole. Increasing the mobility of human resources is an intricate problem due to the inherent complexity of the problem involving issues such as organizational constraints, the employment system, and firm specific customs, but it is a pivotal issue to resolve in order to establish a new type of innovation system based on active involvements of startup firms and SMEs.

These policies must have a great impact on entrepreneurship activities, particularly for high-tech start ups. Support for risk taking activities by entrepreneurs is an important task for the government. According to our analysis, these start up firms invest heavily in R&D as well as R&D networking with other firms, universities etc. There is no doubt that they are a good candidate for high growth SMEs. However, it is also found that there is a transition point from a start up firm to be stabilized. This process is driven by evolutionally process in market competition, so-called Darwinian sea, and it may not be within government reach. However, there is some area where policy can help, such as information dissemination of best practice cases and providing some management supports to SMEs. I would confess that we have not reached the point to say this process is systematically analyzed. Therefore, more academic research (combination of economics of management disciplines) is needed to provide policy recommendation on how to improve success rate of start up companies to become big.

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