RESEARCH DIGEST

Seeking the Differences in Research and Development in Japanese and U.S. Companies

The R&D Process in the U.S. and Japan: Major findings from the RIETI-Georgia Tech inventor survey
Commercialization and Other Uses of Patents in Japan and the U.S.: Major findings from the RIETI-Georgia Tech inventor survey

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Profile

Professor Sadao Nagaoka earned his B.E. in Engineering from Tokyo University and later a Ph.D. in Economics from the Massachusetts Institute of Technology in 1990. He joined the Ministry of International Trade and Industry in 1975 and in 1986 was seconded to the World Bank. He has been a professor of the Institute of Innovation Research, Hitotsubashi University, since 1997 and concurrently held the position of Director from 2004 to 2008. Selected publications include "Assessing the R&D Management of a Firm in Terms of Speed and Science Linkage: Evidence from the US Patents," *Journal of Economics & Management Strategy*, Vol. 16, No. 1, Spring 2007.

The key to economic growth is in research and development (R&D). Is there a difference in the approach to R&D between Japan and the U.S? And what issues does Japan face? Using approximately 5,600 patents held by Japanese and U.S. firms, a project team led by RIETI Faculty Fellow, Sadao Nagaoka, in collaboration with Professor John Walsh from the Georgia Institute of Technology, conducted a survey on the R&D process for the purpose of comparing Japanese and U.S. companies. During our interview, Professor Nagaoka told us the details of this survey, which led to the publication of two discussion papers and shared his long-term perspective for the R&D strategy of Japanese companies.

—What are the purpose, overview, and characteristics of your survey?

The purpose of research and development is to create knowledge and commercialize its outcomes in markets as new products or new production processes. However, as the essence of R&D is knowledge, we do not have effective data to measure it. Therefore, we conducted a survey on a project basis to accurately comprehend R&D processes in Japan and the U.S. In the past, surveys on R&D had often been conducted on a company-by-company basis, but as there are cases where the same company conducts R&D in different industrial areas and with different objectives, we felt we could grasp the actual situations more accurately by understanding the different background of each R&D project and check it with the content of inventions created as a result. The targets were "triadic patents" of relatively good quality, which have already been patented in the U.S. and are applying for patents in Japan and Europe. We conducted the survey in Japan and the U.S. in 2007 and obtained data on 3,658 patents in Japan and 1,919 in the U.S. At the same time, we surveyed non-triadic patents in Japan as well, but used only triadic patents for the comparison between Japan and the U.S.

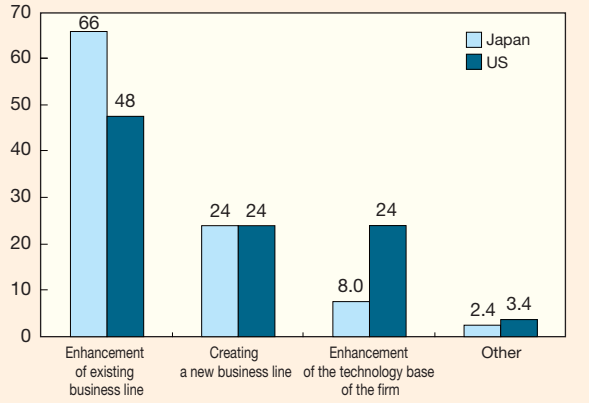
R&D in "strengthening existing businesses" is more pronounced in Japan

—As for the premise for patents, what characteristics did you find in Japan and the U.S. with regard to R&D?

First of all, with respect to the objectives of individual R&D projects, we divided them into four categories: 1) "enhancement of existing businesses," 2) "creating new business line," 3) "enhancement of the technology base of the firm," and 4) "other." We asked those surveyed under which category their R&D projects falls. **Figure 1** shows the results. Although the most popular answer in both Japan and the U.S. was 1) "enhancement of existing businesses," the percentage was higher in Japan than in the U.S. at 66% and 48%, respectively. In addition, though the percentage of respondents who answered 2) "creating new business line" was the same in both Japan and the U.S., there was a major difference as to who conducts R&D in the creation of new businesses. Also, when tallying the percentages of the four objectives by the size of company (four categories: large, medium, small, and smallest), we obtained the result that the percentage of R&D with the objective of "creating new business line" is highest among the smallest companies in the U.S. It is conceivable that this result reflects that U.S. entrepreneurs launching new businesses tend to undertake active R&D.

Another notable finding was that the percentage of R&D with the objective of enhancement of the technology base of the firm is only 8% of overall R&D in Japan, while it is 24% in the U.S. Although the characteristic of attaching importance to the target of enhancing the technology base of the firm, going beyond the scope of existing businesses, exist in almost all industrial sectors in the U.S., it is particularly noticeable in sectors such as semiconductors, information and telecommunications, software, and optics.

Figure 1 **Business Objectives of the Research** (%Yes)



Note: More than 95% of the samples in both countries are from the inventors affiliated with business firm. Based on the common technology class weights.

—What are the reasons for such differences?

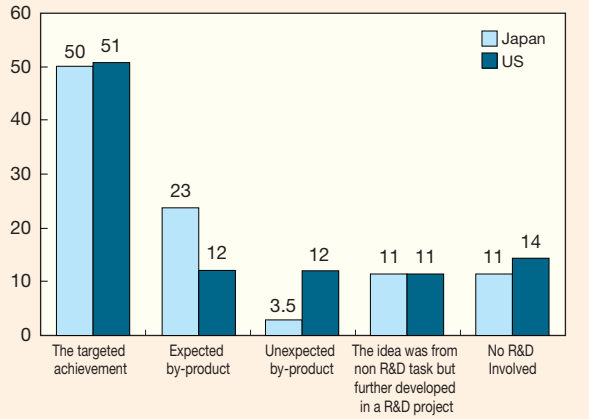
I think the R&D financing system has something to do with these differences, and the role of researchers is also significant. In the survey, we looked into the attributes of researchers and discovered that the percentage of researchers with a Ph.D. was 45% in the U.S. and 12% in Japan. As researchers with a Ph.D. in both the U.S. and Japan tend to constitute a greater portion in R&D for "enhancing the technology base" in comparison with R&D for "strengthening existing businesses" and "creating new business line," it seems that the U.S., which is capable of meeting such needs, ended up focusing more on the enhancement of the technology base.

Rate of serendipity of inventions is higher in the U.S.

—Did you find any other characteristics in R&D processes through which inventions are born?

Inventions created by R&D projects do not always turn out as originally expected. Serendipity refers to unexpected outcomes (inventions that were not initially anticipated), which are also very important. **Figure 2** shows the results of asking which of the following five categories the content of an invention falls under: 1) "the targeted achievement," 2) "expected by-products," 3) "unexpected by-products, i.e., serendipity," 4) "ideas coming from other than R&D but further developed in a R&D project," and 5) "No R&D involved." The result shows that although half of the inventions turned out "the targeted achievement" in both Japan and the U.S., cases in which inventions were created as 3) "unexpected by-products" were 3.5% in Japan and 12% in the U.S., while cases in which they were 5) "No R&D involved" were 11% in Japan and 14% in the U.S. Overall, the U.S. demonstrates a higher tendency toward serendipity, and it seems reasonable to assume that this is related to the difference in research objectives between Japan and the U.S. as described above. That is, the U.S. focuses more on research to develop seeds that are not directly linked with a present business.

Figure 2 **Invention Process** (Targeted v. others)



Note: Based on the common technology class weights

—What kinds of differences did you find in values of inventions?

In the survey, we asked inventors what position ([1] top 10%, [2] top 25% or above, [3] top 50% or above, [4] lower half) they thought their inventions were placed in the technological fields of their inventions. Though this is a subjective assessment, it seems to be a dependable one, given that it is consistent with other evaluation figures, such as citation frequency by other patents. In both Japan and the U.S., there is a tendency that the smaller the company is, the higher the percentage of inventions ranked in the top 10% becomes, in other words, the larger the economic value of the inventions becomes. In contrast, the quality of inventions made by university researchers greatly differs in Japan and the U.S. In the case of Japanese universities, inventions ranked in the top 10% account for only 9.4% of the total, while the ratio jumps to 30% at U.S. universities.

Another difference between Japan and the U.S. is the percentage of inventions in the top 10% accounted for by small companies of 100 employees or less. Although

inventions in the top 10% made by inventors at small companies in Japan account for only 10% of the total, this makes up 21% in the U.S. As a result, important inventions created by universities and small companies make up approximately one quarter in the U.S.

The survey results as described above suggest that the stronger focus of R&D on the enhancement of technology base of a firm independent from existing businesses is one of the causes of the high performance of R&D in the U.S. The results also highlight the picture in the U.S. that such kinds of R&D are undertaken actively, not only by large corporations, but also by small companies and universities.

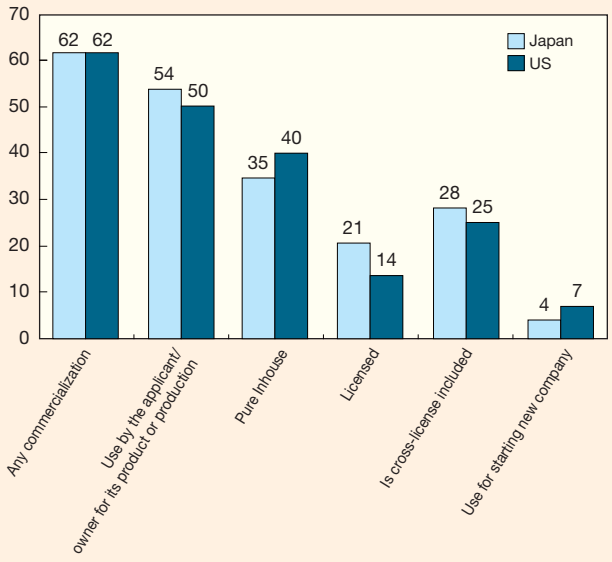
60% of patents are commercialized in both Japan and the U.S.

—Why did you emphasize the commercialization of inventions in the survey?

For inventions to receive high appraisal in the market, or have a specific economic value as new products or production methods, becoming much more than mere inventions, they need to be commercialized. Commercialization refers to inventions actually being used in economic activities in some form, including cases in which they are used for the benefit of another company, through licensing or the founding of a company, and in some cases they are used purely for the businesses of the original inventor company.

As shown in **Figure 3**, 60% of inventions are commercialized in both Japan and the U.S. either through internal use, license or a startup. With regard to the internal use by the applicant, when we compare the percentage of inventions used only internally in Japan and the U.S., conditional on their internal use, the percentage is 65% (=35%÷54%) in Japan and 80% (=40%÷50%) in the U.S. This suggests that inventions are used more exclusively in the U.S. than in Japan. Interestingly, despite the more exclusive use of inventions in the U.S., the percentages of invention use are the same in both Japan and the U.S. This seems to reflect that an exclusive use can give a firm a greater incentive to develop the new use of an invention.

Figure 3 **Commercialization of the Invention**



Note: pure in-house= used by the applicant/owner only for its internal use (neither license nor the use through a startup), based on the common technology class weights.

Meanwhile, as invention use is expected to differ depending on the original R&D objectives with which they were made, we looked into how they are used in Japan and the U.S. for each of the three R&D objectives: 1) “strengthening existing businesses,” 2) “creating new businesses,” and 3) “creating a new technological base.”

We resultantly confirmed three points: (1) In the U.S. a high percentage of inventor companies utilize their own inventions in R&D with the purpose of 3) “creating a new technological base” (43% in the U.S. and 28% in Japan). (2) Overall, the ratio of licensing tends to be lower in the U.S. than in Japan (8%-19% in the U.S. and 17%-23% in Japan). (3) However, regarding inventions in R&D with the purpose of 2) “creating new businesses,” the percentage of inventor companies’ own use of commercialized inventions is lower in the

U.S. than in Japan (75% in the U.S. and 88% in Japan), which suggests that they are being used for licensing and the launching of new businesses under an exclusive contract. Behind this seems to be the fact that the market for the exchange of necessary technologies through the founding of companies and licensing is better developed in the area of new businesses in the U.S.

"First mover advantage" and the patent system

—What are inventions that are not commercialized?

Inventions that are not commercialized account for slightly less than 40% in both Japan and the U.S., and the percentage of commercialization declines according to the objectives of R&D; 1) "enhancement of existing businesses," 2) "creating new business line," 3) "enhancement of the technology base of the firm," **(Figure 3)**.

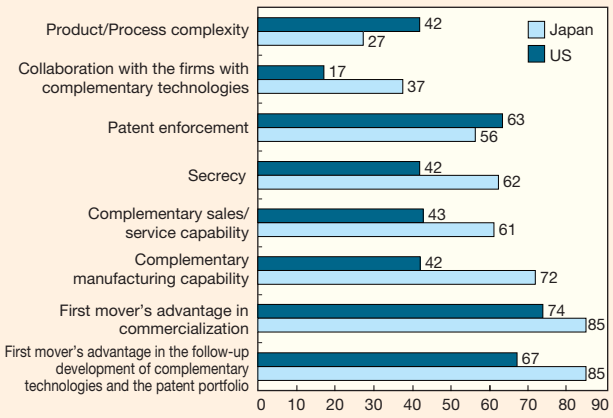
When a company does not have a policy of licensing inventions that are not commercialized to other companies (blocking patents), two main reasons can be inferred. One is that the company may consider the commercialization of inventions when circumstances have changed, although it has not yet made that decision at that moment. The other is that the company may consider that it will not commercialize inventions, irrespective of changes in circumstances. The survey results show that both types of companies exist in similar numbers for all types of inventions with the R&D objectives of 1) "enhancement of existing businesses," 2) "creating new business line," 3) "enhancement of the technology base of the firm. At least in the case of the former type of company, there is a possibility of inventions being commercialized depending on their judgment.

When commercializing inventions, it is also important to have a broad perspective beyond the use of patent protection. The reason companies decide to use, or commercialize inventions is basically to ensure a profit. However, the protection of patent rights is not the only means to ensure profit from an invention. In preceding studies, there are quite a number of examples that cite the so-called first mover advantage (FMA) as a more important element.

—What strategies do companies consider important in trying to appropriate the economic surplus from the inventions?

Figure 4 shows the percentage of companies that answered "important" to each of the appropriation factors; complementary abilities necessary for commercializing inventions, secrecy of inventions, complexity of products and manufacturing processes, as well as the protection of rights under the patent system and FMA. In the figure, the percentage of companies answering "important" or "very important" is highest in FMA in both Japan and the U.S., followed by complementary capabilities for sales and manufacturing in Japanese companies. By contrast, the percentage of companies that emphasize the enforcement of patent rights is relatively high in U.S. companies. Although

Figure 4 **Appropriation Strategies** (% high)



Note: Based on the sample of the inventions already commercialized internally and on common technology class weight

we have already confirmed that the tendency of using inventions exclusively is stronger in the U.S. than in Japan, it may be possible to presume that such tendency for the U.S. companies to place weight on the exclusive license of inventions is connected with this finding.

Moving toward frontier-type R&D

—From the survey results, what implications did you obtain as to the role of R&D in business or related government policies?

As the survey clearly shows, R&D in Japan attaches importance to the "strengthening of existing businesses." It is expected that in such research the rate of return will decline as the businesses mature. Meanwhile, U.S. companies focus on the cultivation of technology base and the development of seeds for new businesses, irrespective of existing businesses. Japanese companies, too, need to shift to frontier-type R&D in the future. To that end, an increase in researchers with a Ph.D may be necessary as in the U.S.

In terms of the players in R&D, it has been identified that the role taken by small companies and universities in the U.S. is different to that in Japan. In the U.S., small companies and universities function as more important players for the important inventions. In Japan, while the necessity for policy support has been recognized for some time, R&D financial issues, such as how to secure risk money providers, remain important.

There is also an institutional issue of patent protection. As the survey result for the U.S. shows, stronger exclusiveness does not necessarily impede the creation and commercialization of inventions but, to the contrary, can play a role of facilitating commercialization by improving the rate of return of intellectual property. It may be necessary to also look at the institution from such a perspective in Japan.

—What is the future direction of your research?

As one example, I would like to undertake a deeper analysis on the differences between R&D researchers in Japan and the U.S. While I have highlighted the difference in the level of education between the two nations, other issues, such as how companies provide incentives to researchers, are likely to be important points of further analysis. In addition, the issue of collaboration between different companies has also become important. Given that this type of research has already accounted for more than 10% in both Japan and the U.S. and, at the same time, many of the patents from such R&D are jointly owned in Japan, this issue is expected to become more important in the future.

Nagaoka & Walsh, co-author of the paper, making a presentation at RIETI's seminar