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2B02　　　　　日本企業の外国人研究者の雇用状況に関する分析

○藤末健三（東大工学）

Abstract
In Japan, the shortage of researchers is expected to be 1.76 million in 2010 by rapid aging of Japanese society. Japanese Economic White Paper of 1999 also said that Japan should discuss foreign labor employment in knowledge works. In this study, we examine what kinds of Japanese companies employs foreign researchers through a questionnaire survey. This questionnaire survey was delivered to 830 Japanese companies in Tokyo First Stock Market and got 250 responses (the response rate is about 30%).
As a result of the study, we found that Japanese companies that already employed foreign researchers evaluated foreign researchers highly and Japanese firms with the greater sales (business) and R&D scales tend to employ the larger number of foreign researchers.

1.　Introduction

From a long-term perspective, aging of the population is progressing in Japan at a speed that has no parallel in the rest of the world. The Japan Professional Engineer Association forecasted that the shortage of researchers is expected to be 1.76 million in 2010 by rapid aging of Japanese society (figure 1 and 2).
In order to deal with such shortage of researchers, Japan can have mainly three options; 1) to use women researchers more, 2) to use retiring researchers and 3) to increase foreign researchers more (Industrial Technology Council, 1998). To increase foreign researchers in Japan is the easiest and quickest way to keep potentiality of Japan's R&D because deregulation on immigration of foreign researchers have quick effect on this and the U.S. had already had a good experience in 1990s (Schmidt, 1991).

Regarding with foreign researchers' employment in U.S. high-tech companies, We will refer to Stuart Anderson's report on immigrants and high technology industry and discuss the impact of immigrants in some key areas. In his report on immigration and high technology, Stuart Anderson writes that, "in 1995, 12% of the Inc. 500--a compilation of the fastest growing corporations in America--were companies started by immigrants." He gives a list of 11 high tech software and hardware companies that were started in part or wholly by immigrants. These companies include industry giants like Intel with 29,000 U.S. employees and revenue of $11.5 billion as of January 1995, and Sun Microsystems with 11,000 U.S. employees and revenue of $6.0 billion as of January 1995. Intel's CEO, Andy Grove, was a Hungarian refugee who studied in U.S. institutions before working at AT&T Bell laboratories and then creating Intel with 2 cofounders. Two foreign-born engineers started Sun Microsystems.

The list includes smaller companies like Atmel and Cypress Semiconductor who have 2,000 and 1,500 U.S. employees respectively and had annual revenue of $600 million as of January 1995.
Regarding with executives in high-tech companies, we refer to Stuart Anderson's report on immigration and high tech industry again. The report discusses the case of Sun Microsystems where an immigrant from India, Anant Agarwal, is the vice-president of engineering. Agarwal had joined the company when it had 300 employees. He and another immigrant were principals in SPARC processor design that led to a change of fortune for Sun Microsystems. Today, Agarwal heads a division of 350 engineers.
Applied Materials is the world leader in semiconductor manufacturing systems. An article of Greengard, S (1995) reports that more than 50% of Applied Materials' top managers are foreign-born. This includes their president and many of their top executives. The same article reports that Texas Instruments (TI) also has foreign-born individuals in their senior management. The president of TI's Calculator and Personal Notebook Group and the president of TI Asia are both foreign-born. The CEO of Compaq is also non-US citizen, German.
And also, in the Human Resources section of the magazine International Business, Lori Ioannou (1995) reports on the import of foreign executives to the United States. She reports that AT&T Corporation has a non-U.S. workforce of 56,000 in 90 countries. They have brought in 130 high level managers and executives into the United States for training in current technology and business. These people come for assignments of two to four years and from various countries including China, Japan, France, Germany, and United Kingdom. The

report further claims that most of these executives return to the subsidiaries in their home countries.

2. A Questionnaire Survey
2.1. Outline of the Survey
Based on the company information of "Nikkei Company Information" CD-ROM 98 New Year Edition (Information as of end-December, 1997), questionnaires were sent out to the Research Management Department of 839 firms which are presumed to have annual Research and Development expenses exceeding 1 billion. The questionnaire survey was conducted in February 1998, and the number of replies obtained was 250 firms, which is a recovery rate of 29.8%.

This questionnaire survey is composed as follows in order to conduct survey of present situation and future plans for employment of foreign researchers in firms in Japan. As for the details of the survey contents, refer to the attached questionnaire survey format.
* Whether any foreign researchers were employed in Japan or not and the reason.
* Plans for employing foreign researchers in future and the reason.
* Countermeasures for decrease in researchers and technicians owing to less children and disliking of technical matters by young persons, and request to the Government.

2.2. Outline of the Result
Our questionnaire survey shows that Japanese companies would promote employment of foreign researchers. In our survey, about half of respondents answered that employment of foreign researchers was successful and about 30% expected future success (figure 3).

In another question of our survey, 56% of companies that already employed foreign researchers planed to increase the number of foreign researchers. In contrast, only 6% of companies without foreign researchers planed to employ foreign researchers and 40% of them had no plan to employ foreign researchers. This means that companies that once employed foreign researchers evaluated foreign researchers highly and companies' needs for foreign researchers will increase in future (figure 4).

2.3. Reasons of employing foreign researchers
The figure 5 shows why Japanese companies employed foreign researchers. 50% of companies that already employed foreign researchers expected 'high technical skill and knowledge' and '41% of them expected different perception and ability of foreign researchers.' Relatively less companies answered construction of international researchers network.

Since 1986, the Plaza Accord, the Japanese yen became appreciated. Along with appreciation of yen, Japanese companies established research institutes in foreign countries and also R&D expenditure is rising in 1990s. A survey (Fujisue, 1998) said, in around 60% of foreign research institutes of Japanese companies, over 75% of

staffs were foreigners. Under such circumstance, Japanese companies are expected to promote employment of foreign researchers.

3. Numerical Analysis of the Questionnaire Survey
3.1. Hypothesis
What types of firms are positive toward the employment of foreign researchers? It appears the firms eager to employ foreigners are those which underline R&D efforts (verified), which concentrate the efforts on the introduction of overseas technologies (not verifiable), which have growing R&D budget (not correlated), which rank high in the industry (not correlated), which are exports-dependent (not verifiable), which install production/R&D units overseas (not verifiable), which seek new breakthroughs (not verifiable), and which belong to the industry of ultra-fast technological advance (not verifiable).

3.2. Verification of the hypothesis
(1) Verification method
Based on the specific data gained by a questionnaire on the employment of foreign researchers, etc. (conducted in FY1997), the relations between following dependent and explanatory variables were analyzed with regression analyses (simplex, duplex regression).
1) Dependent variables:
● Share of foreigners in the total number of researchers of a given firm (FY1996 yearend)
● Share of foreigners in the number of researchers employed by a given firm (average in FY1995-97)
● If or not foreign researchers were employed in FY1995-97 (0/1)
2) Explanatory variables
● Sales, number of employees, R&D budget, number of researchers, R&D budget/sales, number of researchers/number of employees
(From questionnaire results: FY1996 data)
● Growth of R&D budget (FY1997 estimated/FY1996 records), industry-wide sales ranking (FY1996)
(From Nikkei's "Corporate Information" CD-ROM used in sending the questionnaire.)
(2) Verification results
1) Share of foreigners in the total number of researchers of a firm
(Analysis target: All the corporate respondents, incl. those answered they had no foreign researchers.)
As shown in the significant case in the attached table (see the Excel file attached), the higher shares of foreign researchers were noted among the firms with the higher sales or the larger R&D budget, namely the firms characterized by the larger scale of sales or R&D budget.
As for the R&D budget/sales ratio, a statistically significant relation was noted with the minus-signed coefficients. This can be considered as that a minus correlation of the R&D budget/sales ratio emerges

because the greater contribution is made by sales than R&D budget.

Meanwhile, no significant correlation was noted with the number of researchers, the growth of R&D budget, and industry-wide sales ranking.

The duplex regression analysis, though conducted in various ways, did not produce statistically significant results, either.

2) Share of foreigners in the number of researchers employed by a firm

(Analysis target: Only the corporate respondents that answered they employed foreign researchers.)

As shown in the attached table, the shares of foreign researchers tended to be the higher among the firms employing the larger number of researchers.

In the meantime, statistically significant relations were not noted with the remaining explanatory variables.

3) If or not foreign researchers were employed in FY1995-97

(Analysis target: All the corporate respondents, incl. those answered they had no foreign researchers.)

As shown in table 1, significant relations were noted in a duplex regression analysis with the sales and the number of researchers. It can be interpreted that the firms with the greater business and R&D scales employ the larger number of foreign researchers.

Organization of results and future subjects

As already mentioned, the firms with the greater sales (business) and R&D scales tend to employ the larger number of foreign researchers. However, no facts were confirmed that the larger number of foreign researchers were employed by the firms characterized by the higher R&D budget/sales ratios or the higher researchers/total workforce ratios. Also, the growth of R&D budget and the industry-wide sales ranking were found correlated little to the employment of foreign researchers.

There is room for additional analyses on such factors as the level of concentration on overseas technological introduction, export ratio, overseas production ratio, weight of overseas R&D, needs for new breakthroughs, and industry exposed to ultra-fast technological advance. However, it must be noted, in regard to the employment of foreigners, the Japanese firms provide so limited number of samples that should pose considerable limits to making a statistical analysis.

4. Conclusion

We can summarize the result of this study as followings:

1) Increasing employment of foreign researchers in Japan is one of important measures to deal with future shortage of researchers in Japan. The U.S. already had promoted foreign researchers employment and made success in high-technology industry.

2) Japanese companies that already employed foreign researchers evaluated foreign researchers highly and companies' needs for foreign researchers will increase in future.

3) Japanese firms with the greater sales (business) and R&D scales tend to employ the larger number of foreign researchers.

As analyzed above, foreign researchers played an important role in the economic recovery of the US in 1990s. Japan's core competitiveness should be manufacturing industry. Japan should gather excellent brains not only from Japan but also from foreign countries such as China and India in order to vitalize manufacturing industry and compete with other industrialized countries. From a viewpoint of long term, Japan will face the shortage of high-skilled labor in near future and foreign researchers will be important to overcome such a hurdle.

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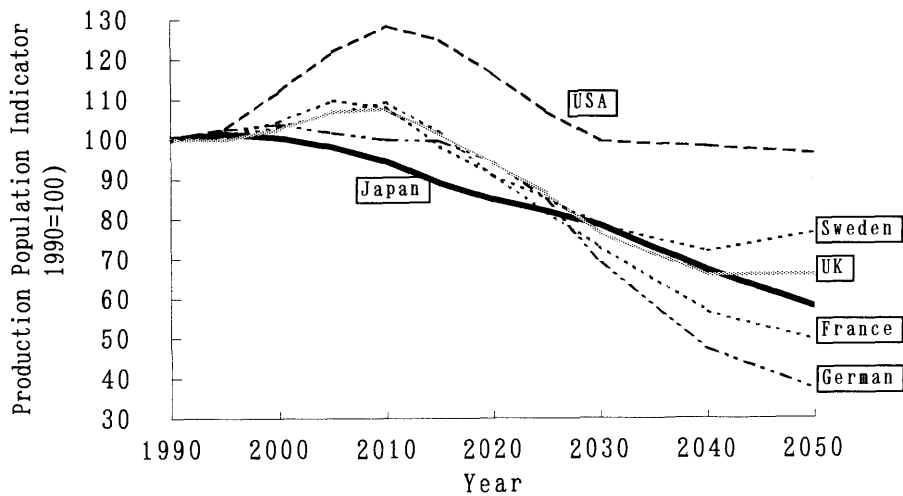
Source: World population prospects 96, United Nations, Estimated Population of Japan
(January, 1998), National Social-Welfare and Population Research Institute and Statistics
on Population, Ministry of Health

Figure 1. Decreasing Production Population in Japan.
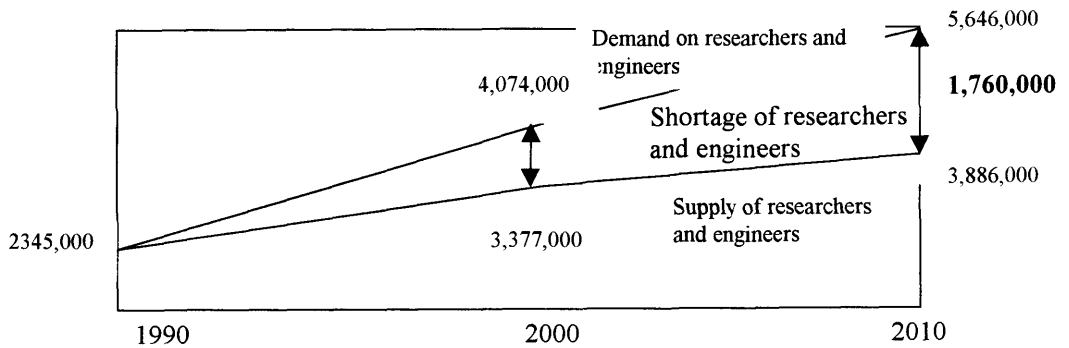
Source: Professional Engineer Association, 1994.
Note: GDP growth rate during 1990 – 2000 is 2.8% and GDP growth rate during 2000-2010 is 1.7%.
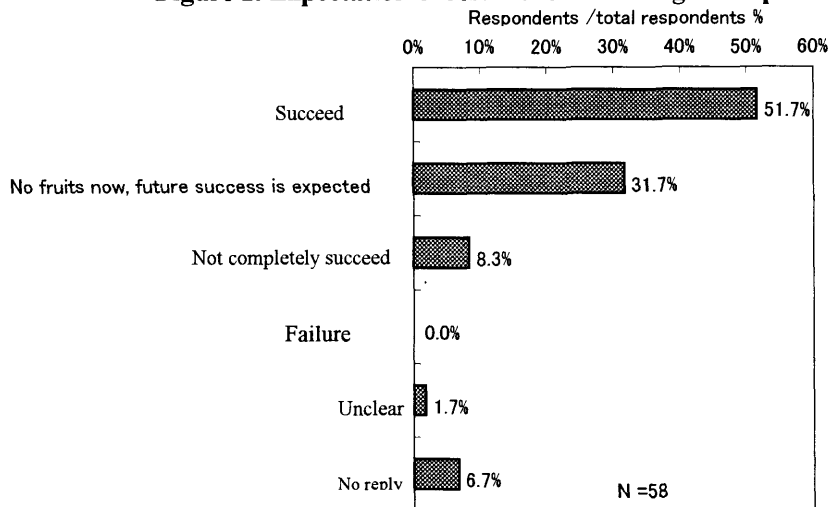
Figure 2. Expectation of researchers' shortage in Japan
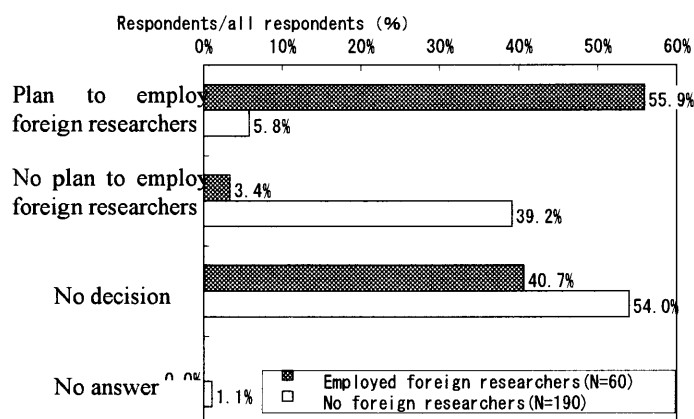

Figure 3. Evaluation of foreign researchers

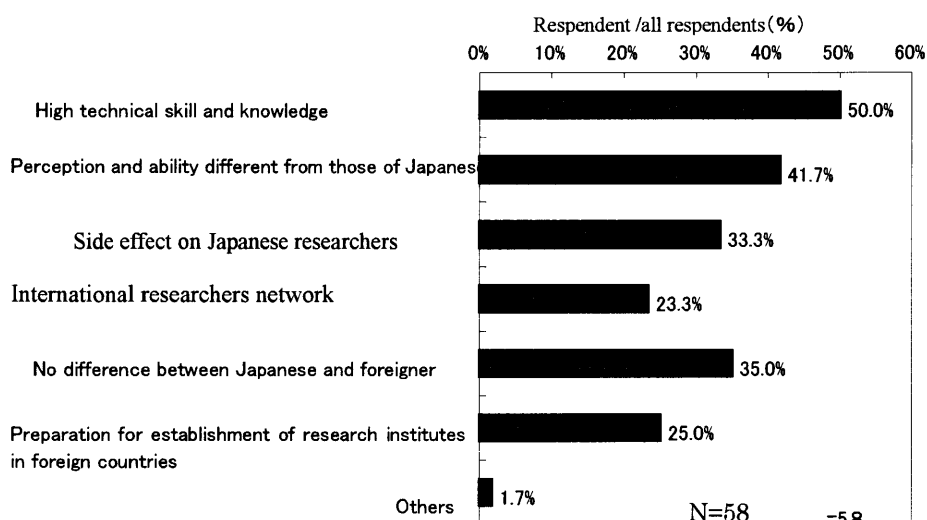**Figure 4. Plans of Japanese companies to employ foreign researchers.**

Figure 5. Reasons of employing foreign researchers.

Table 1. A duplex regressive analysis on sales and number of researchers of Japanese Companies.

Non-explanatory variable	Share of foreigners in the number of researchers employed (average in FY1995–97)
Samples:	Only the corporate respondents that answered they employed foreign researchers in FY1995–97 (excluding those giving no answers)

Significant case
** 1% significance
* 5% significance

Explanatory variables:

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
Sales	7.86319E-06	0.1753	1.3958	1.1814	0.2438	
Constant term	0.223438447		10.8158	3.2887	0.0020	**

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0307	0.0087	0.1753	0.0934	2.0276	47.0649

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
Number of employees	8.85741E-06	0.2724	3.5264	1.8779	0.0670	
Constant term	0.203855998		9.6808	3.1114	0.0033	**

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0742	0.0532	0.2724	0.2306	2.0813	44.9551

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
R&D budget	0.000116392	0.2161	2.1548	1.4679	0.1492	
Constant term	0.232025404		14.0396	3.7469	0.0005	**

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0467	0.0250	0.2161	0.1582	1.9914	46.3021

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
Number of researchers	7.41057E-06	0.3902	7.1023	2.1111	0.0073	**
Constant term	0.210434705		13.2526	3.6404	0.0007	**

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.1523	0.1320	0.3902	0.3641	2.0443	40.9038

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
R&D budget/Sales	0.862797791	0.0794	0.2727	0.5222	0.6042	
Constant term	0.229828565		6.0851	2.4668	0.0177	*

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0063		0.0794		1.9607	48.1761

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
No. of researchers/no. of employees	0.454923771	0.0892	0.3530	0.5941	0.5555	
Constant term	0.218282572		4.9690	2.2291	0.0310	*

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0080		0.0892		1.9508	48.1339

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
Growth rate of R&D budget	0.146691552	0.0427	0.0730	0.2702	0.7884	
Constant term	0.08637196		0.0226	0.1502	0.8814	

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0018		0.0427		1.8728	40.4664

Variable	Partial regression coefficient	Standard regression coefficient	F value	T value	P value	Judgement
Ranking in sales industry-wide	-0.00245861	-0.2302	2.4612	1.5688	0.1239	
Constant term	0.337433666		20.8438	4.5655	0.0000	**

Coefficient of determination	Corrected coefficient of determination	Duplex correlation coefficient	Corrected duplex correlation coefficient	Darbin-Watson ratio	Akaike's A/C
0.0530	0.0314	0.2302	0.1773	2.1456	45.9978