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Roles of Education and Training at Universities and Private Industries for Technological Development: A France-Japan Comparison

By

Hajime Imamura

Abstract

This is a preliminary investigation of the role of universities in technological and human resource development in Japan. The purpose of this paper is to gather some empirical data about the roles of research and education in universities for the technological development of Japanese private industries. To re-design the Japanese higher education system to fit contemporary social economic contingencies, it is necessary to understand the present reality of industry-university relationships in the fields of technological development and human resource development.

Universities are not only the source of human resources, but also the center of the human resources network. Universities must increase their research and education capability for technological development. Although the budgets are low, the functional role of universities in networking will continue to be important.

There are two implications from this France-Japan comparison of human resource development for technological development. One is the need for overall strategic view of human capital formation in coordination with the strategy for technological development. The second implication is that the government should offer a precise and organized system of education and occupational skills with closer links to social and business organizations.

Key Words

education and training, technological development, university education, occupational qualifications, human resource, research and development, research fund

Introduction

This is a preliminary investigation of the role of universities in technological and human resource development in Japan. The purpose of this paper is to gather some empirical data about the roles of research and education in universities for the technological development of Japanese private industries. To redesign the Japanese higher education system to fit contemporary social economic contingencies, it is necessary to understand the present reality of industry-university relationships in the fields of technological development and human resource development.

However, the roles of universities for technological development and human resource development in Japan are complex. We start with two hypothetical roles of

Japanese universities for technological development. Japanese universities behave as a) the supplier of highly educated human resources for technological development, especially from post-graduate courses, and b) the core of the information network on technological development through industry-university research cooperation networks.

We should note that universities are not the only place for the education and training of engineers and researchers, as companies train their employees to fit the goals of their business activities. In reality, this corporate education and training is the main source of human capital formation for technological development, and has been contributing to economic growth.

In the usual case for employees, using the internal labor market system, the company places those newly recruited at the lower level of the job ladder, and then trains, educates and promotes them to higher positions on the job ladder. This system of internal training and promotion is applied even in organizations of research and development in Japan. To use such a system, companies look not for those most highly educated, but those most trainable.

The role of universities as the center of research information and research projects can be supported at least with regard to the engineering field. Private industries work as the supplier of important financial resources in return for the research information and supply of excellent graduates to the industries.

Flows of Research Funds among Industries, Universities and Government

Research Cooperation in Japan

Research cooperation among industries, universities and government is shown in Figure 1. There are several measures to promote inter-organizational research cooperation in Japan: joint research *(kyodo kenkyu)*, consignment research *(itaku kenkyu)*, consignment researcher *(shourei kenkyu-in)*, subsidiary fund *(shourei kenkyu)*. The central government, especially the Ministry of Education, coordinates these different measures to promote industry-university research cooperation and some other types of cooperation.

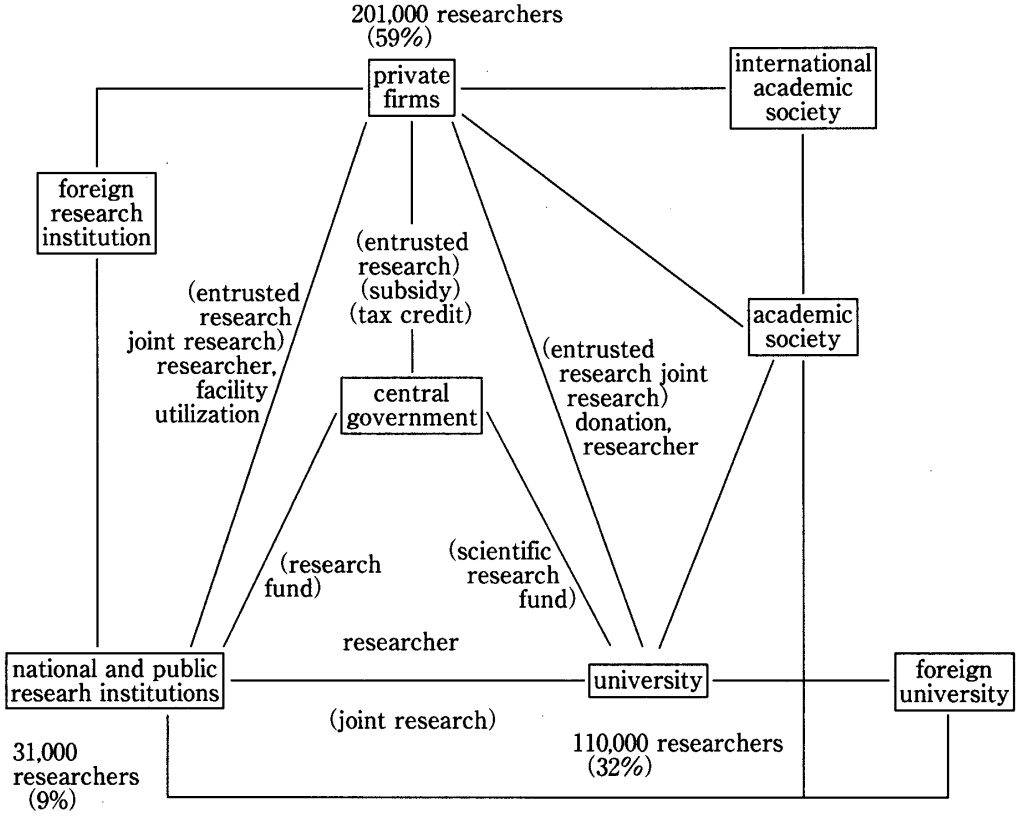
For universities, the subsidiary fund from private firms and the scientific research fund from the Ministry of Education are the two major sources of research funds. Joint research does not provide a major source of research funds, because the procedure to be authorized as "joint research" from the Ministry of Education is rather complicated.

Flows of Research Funds in Japan

In Japan, most research funds are used within industries, whereas the flow of research funds to universities is scarce. The proportion of research spending in private industries amounted to nearly three-quarters of total research spending in 1991.

Figure 2(a) shows how research funds circulated among private industries, universities and government in 1993. 72.3 percent of total research spending was spent in private industries. Only 3.13 billion yen flows to universities from private industries, which have 930 billion yen of research funds. The main supplier of research funds for universities is the government. The flow from the government to universities amounts to 105 billion yen, which is more than 60% of total research spending in universities.

Figure 1. Research Cooperation among Private Firms, Government and Universities Japan (1985)

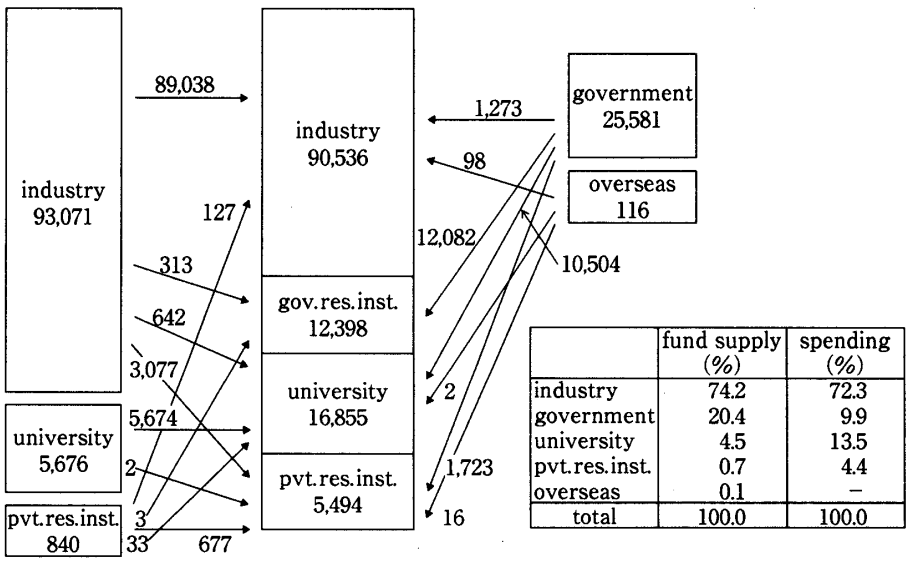


Source: Masuda, 1987

Figure 2(a). Circulation of Research Funds in Japan and in France

(a) Japan (1993) (100 million yen)

private fund 99,587 total spending 125,284 overseas fund 116 government fund 25,581

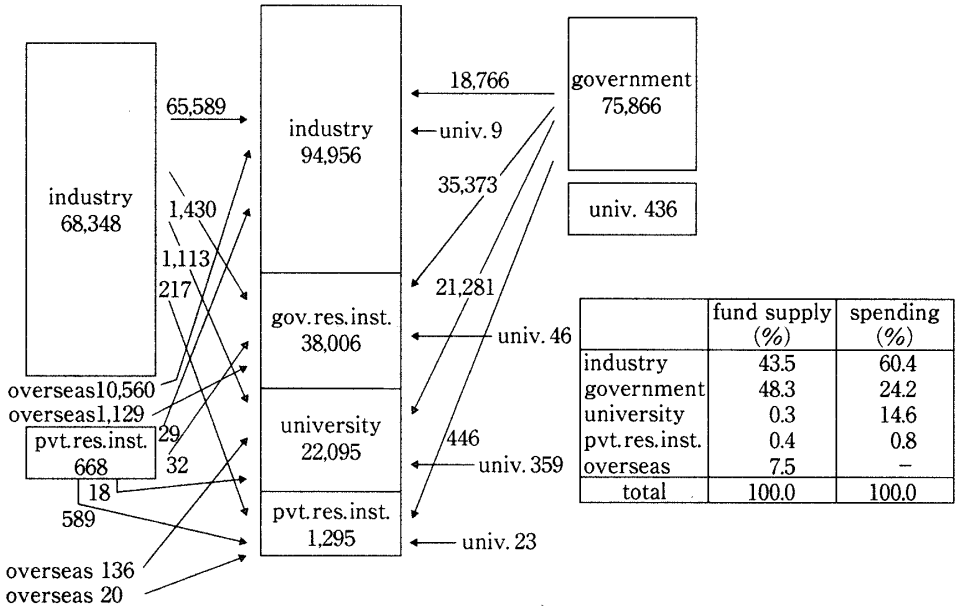


	fund supply (%)	spending (%)
industry	74.2	72.3
government	20.4	9.9
university	4.5	13.5
pvt.res.inst.	0.7	4.4
overseas	0.1	–
total	100.0	100.0

Figure 2(b). (Continued)

(b) France (1990) (1 million francs)(Numbers in parentheses are in 100 million Yen)

private fund 69,015 (18,351) total spending 157,162 (41,789) overseas fund 11,845 (3,150) government fund 76,302 (20,289)



	fund supply (%)	spending (%)
industry	43.5	60.4
government	48.3	24.2
university	0.3	14.6
pvt.res.inst.	0.4	0.8
overseas	7.5	–
total	100.0	100.0

Source: White Paper on Science and Technology (1995, Science and Technology Agency)
Original Source: Basic and Technology Statistics (OECD)

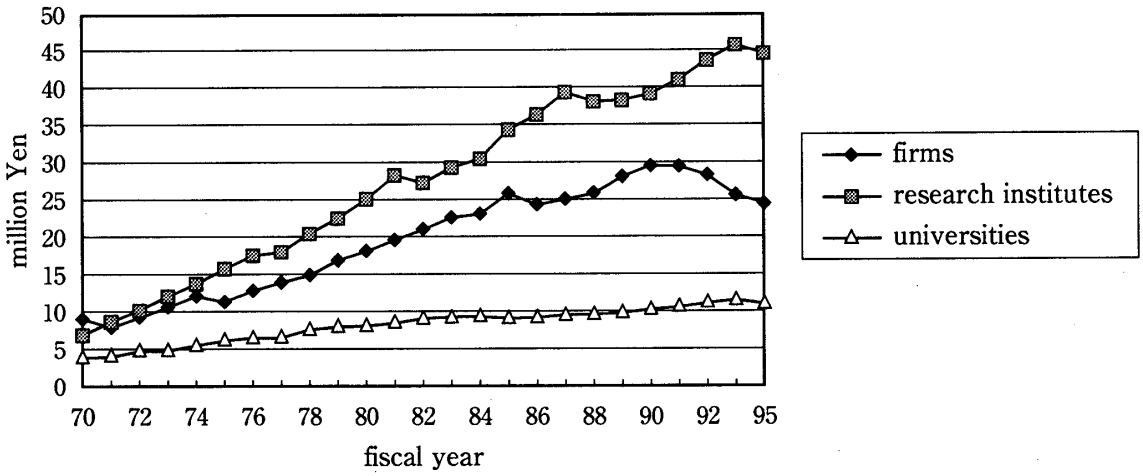
France-Japan Comparison of Research Funds Flow

Looking at Figure 2 (b) in comparison to 2 (a), we can see that there are some significant differences between France and Japan in the flow of research funds. With regard to the supply of research funds, the government is the major supplier of research funds in France, whereas private industries are the major source of research funds in Japan. More precisely, the proportion supplied by government is 48.3% in France and 20.4% in Japan. Private industry supplies 43.5% in France and 74.2% in Japan.

With regard to research spending, private industries account for approximately three-fourths of total spending in Japan, whereas spending by French government institutions is more than twice that in Japan. Research spending by private industries is 72.3% of total spending in Japan and 60.4% of total spending in France. Government research institutions account for 24.2% in France and only 9.9% in Japan.

From this comparison, we can conclude, first, that private industry is by far the major contributor for technological development in Japan, as both supplier and spender of research funds, and contributes a larger proportion of research funds than French private industry. Second, the French government contributes more to technological development through both funding supply and spending in comparison to the Japanese government. Third, universities in both countries show no significant difference as far as the flow of research funds is concerned. We should look more precisely into the mechanisms of technological development centered around universities in both countries.

Figure 3. Annual Research Spending per Researcher



Source: White Paper on Science and Technology (1996, Science and Technology Agency)

Comparison of Research Spending per Researcher

Figure 3 shows that average research spending per researcher in Japanese universities is far below that in research institutes or in private industry. In 1991, research spending per researcher at research institutions was about 40 million yen, and 29 million yen in private industries, whereas it was only 10 million yen at universities. Research conditions for university professors and researchers, on average, are very low in comparison to those in research institutes and private industry.

Flows of Human Resources and Exchange Networks

Research Networks among Universities and Private Industries

There are several ways to exchange researchers between private industries and universities. As described above, one possibility is the movement following the flows of research funds: joint research and entrusted researchers. Another possibility is new recruits from universities. As will be described later, more than 40% of students are majoring in engineering which is an important source of middle level engineers in private industries.

Basically, in these two ways, universities have their own human resource networks with private industries. However, these two are not independent. For example, a firm which expects to employ excellent students from certain numbers of universities make some financial contribution to the research projects of professors in exchange for the increased possibility of hiring new recruits from the universities.

Government Intervention in Industry-University Research Cooperation

Over-regulation and intervention by the government may cause adverse effects for research promotion. Two cases are shown below.

Public employment law actually prohibits professors in national universities from participating in industry-university cooperative research projects. If a professor of a national university wants to do research outside his/her workplace, he/she can work only on Saturday afternoon, at least according to the written documents. This kind of

restriction discourages professors from engaging in industry-university cooperative research projects.

As described above, government intervention into joint research between private industries and universities shows us the typical situation of joint research between these two institutions in Japan. It is apparent that the role of the Ministry of Education is to promote joint research between industries and universities. However, to be authorized as "joint research" by the government and to be able to get subsidies from the government is not easy because of the strict definition of "joint research." For better promotion of industry-university research cooperation, the role of government may have to be re-examined.

Roles of Universities and Private Industries in Human Resource Development

The Role of Universities as the Supplier of Human Resources to the Economy

In Japan, about three-quarters of undergraduate students are educated in private universities. Table 1 shows that the percentage of students educated in private universities are 73.4% of total students in 1993, whereas the students educated in national or public universities are only 26.6 percent.

Table 1. Number of Univ. Graduates, Hired by Japanese Industry

	1983	1984	1985	1986	1987	1988
All Univ.	1,834,493	1,843,153	1,848,698	1,879,532	1,934,483	1,994,616
National Univ.	435,512	442,503	449,373	461,427	477,250	491,539
Public Univ.	53,517	54,117	54,944	55,717	57,358	59,216
Pvt. Univ.	1,345,464	1,346,533	1,344,381	1,362,388	1,399,875	1,443,861
	1983	1984	1985	1986	1987	
All Univ.	2,066,962	2,133,362	2,205,516	2,293,269	2,389,648	
National Univ.	504,890	518,609	528,687	543,198	561,822	
Public Univ.	61,264	61,140	66,694	69,522	74,182	
Pvt. Univ.	1,500,808	1,550,613	1,610,135	1,680,549	1,753,644	

Note: Includes graduate students and auditing students.
Source: Basic Statistics on School Education (1994, Ministry of Education)

As shown in Tables 2 and 3, about 40% of undergraduate students are majoring in social sciences, whereas more than 40% of master's course students are in engineering fields. Of doctoral course students, close to 40 percent are in medical and dental fields.

Table 3 shows three typical characteristics of Japanese higher education and industry recruitment. Most white-collar workers, including future management candidates, are hired just after finishing their undergraduate education. Most engineers in research and development, including future management candidates, are hired just after finishing their master's course. For doctoral courses, the proportion of students in social sciences and engineering is small compared to those studying medicine.

Table 2. Proportion of Undergraduate Students in Each Area of Study

(%)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
total	100	100	100	100	100	100	100	100	100	100	100
humanities	14.1	14.2	14.2	14.4	14.5	14.7	15.1	15.4	15.6	15.4	15.8
social science	39.3	39.0	38.7	38.6	38.8	39.1	39.4	39.6	39.9	39.8	40.0
science	3.3	3.4	3.4	3.4	3.4	3.3	3.3	3.4	3.4	3.4	3.5
engineering	19.6	19.7	19.8	19.9	19.8	19.8	19.7	19.6	19.6	19.6	19.6
agriculture	3.4	3.4	3.5	3.5	3.4	3.4	3.4	3.3	3.4	3.3	3.2
medicine/dentistry	4.3	4.3	4.3	4.2	4.1	3.9	3.7	3.4	3.5	3.2	3.1
pharmacy	2.0	2.1	2.1	2.1	2.1	2.0	2.0	1.8	1.9	1.8	1.7
domestic science	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
education	7.7	7.8	7.8	7.8	7.5	7.5	7.2	6.9	7.1	6.7	6.6
others	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.6	4.5	4.8	4.8

Note: Totals in each column do not necessarity equal 100 due to rounding.
Source: Basic Statistics on School Education (1994, Ministry of Education)

Table 3. Proportion of the Graduate Students in Each Area of Study

(%)

		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
master's course	total	100	100	100	100	100	100	100	100	100	100	100
	humanities	13.3	12.4	11.7	11.3	10.8	10.5	10.2	9.7	9.2	9.0	9.0
	social science	9.7	9.4	9.1	9.1	9.2	9.5	9.9	10.3	10.6	10.8	10.9
	science	9.9	9.7	9.5	9.8	9.9	10.3	10.6	10.5	10.2	10.0	10.1
	engineering	41.2	41.8	42.9	43.5	43.9	45.1	46.0	45.9	46.1	46.0	45.7
	agriculture	10.6	10.6	10.2	9.8	10.1	8.4	6.6	6.5	6.6	6.7	6.7
	medicine/dentistry	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1
	pharmacy	3.8	3.8	3.8	3.7	3.7	3.7	3.9	3.8	3.6	3.6	3.5
	education	6.8	7.4	8.0	8.0	7.8	8.0	8.2	8.6	8.8	8.6	8.5
	others	4.6	4.6	4.6	4.6	4.5	4.4	4.5	4.5	4.7	5.1	5.4
doctoral course	total	100	100	100	100	100	100	100	100	100	100	100
	humanities	15.8	15.3	15.0	14.3	13.4	13.0	12.8	12.7	12.2	12.0	11.4
	social science	12.2	11.9	11.3	10.7	10.3	9.8	9.6	9.4	9.2	9.0	8.8
	science	12.1	12.1	11.5	10.9	10.9	10.9	11.0	10.8	11.0	11.0	11.4
	engineering	11.1	10.8	11.2	12.2	13.0	14.1	14.3	15.2	16.3	17.5	18.8
	agriculture	5.2	5.0	5.1	5.3	5.4	5.7	5.7	6.1	6.5	6.9	7.3
	medicine/dentistry	37.0	38.6	39.7	40.5	40.6	40.2	40.2	39.3	38.3	37.0	35.2
	pharmacy	2.2	2.1	2.1	2.0	2.1	2.1	2.0	1.9	1.8	1.9	1.9
	education	2.9	2.8	2.8	2.8	2.6	2.4	2.3	2.4	2.3	2.3	2.2
	others	1.3	1.3	1.4	1.4	1.6	1.9	2.2	2.2	2.3	2.5	3.0

Note: Totals in each column do not necessarily equal 100 due to rounding.
Source: Basic Statistics on School Education (1994, Ministry of Education)

Industries and Professions of New Recruits from Higher Education

The general characteristics of workers among industries and occupations are as follows. The proportion of female workers in manufacturing industries is rather small compared to male workers, while the proportion of female workers in the service sector is larger than that of male workers. By occupation, office workers comprise the largest share. The share of male engineers and salespersons is very large in comparison to females in those occupations.

The engineer category consists mainly of master's degree holders. If we compare the composition of majors in graduate study by industry, engineering was the largest in Japan and the U.S. Among the developed countries, the number itself is very large in the U.S., and Japan has the second largest number of degree holders in natural science.

Training and Promotion System for Laboratory Researchers

Research and development workers fall under the same rules of training and promotion as other workers in the internal labor markets of Japanese companies. That is to say, most Japanese researchers experience job rotation and participate in management training while giving up time to do their own research work. Table 4 shows that the possibility of job rotation for Japanese researchers is more frequent than for those in the U.K.

Table 4. U.K.-Japan Comparison of the Rotation of Researchers
(Percentage of Researchers who were Rotated to Other Places/Functions/Positions)

	research		development/design	
	Japan	U. K.	Japan	U. K.
a) another laboratory	27.7	33.3	25.5	9.8
b) design	8.0	4.2	44.1	24.6
c) production technology	8.8	5.6	17.4	4.1
d) sales	4.4	4.2	3.7	2.5
e) management of R & D	28.5	23.6	20.5	20.5
f) another management	5.5	9.7	8.1	4.9
g) allied company	12.9	4.2	24.8	1.6
cumulative percentage	95.6	84.8	144.1	68.0

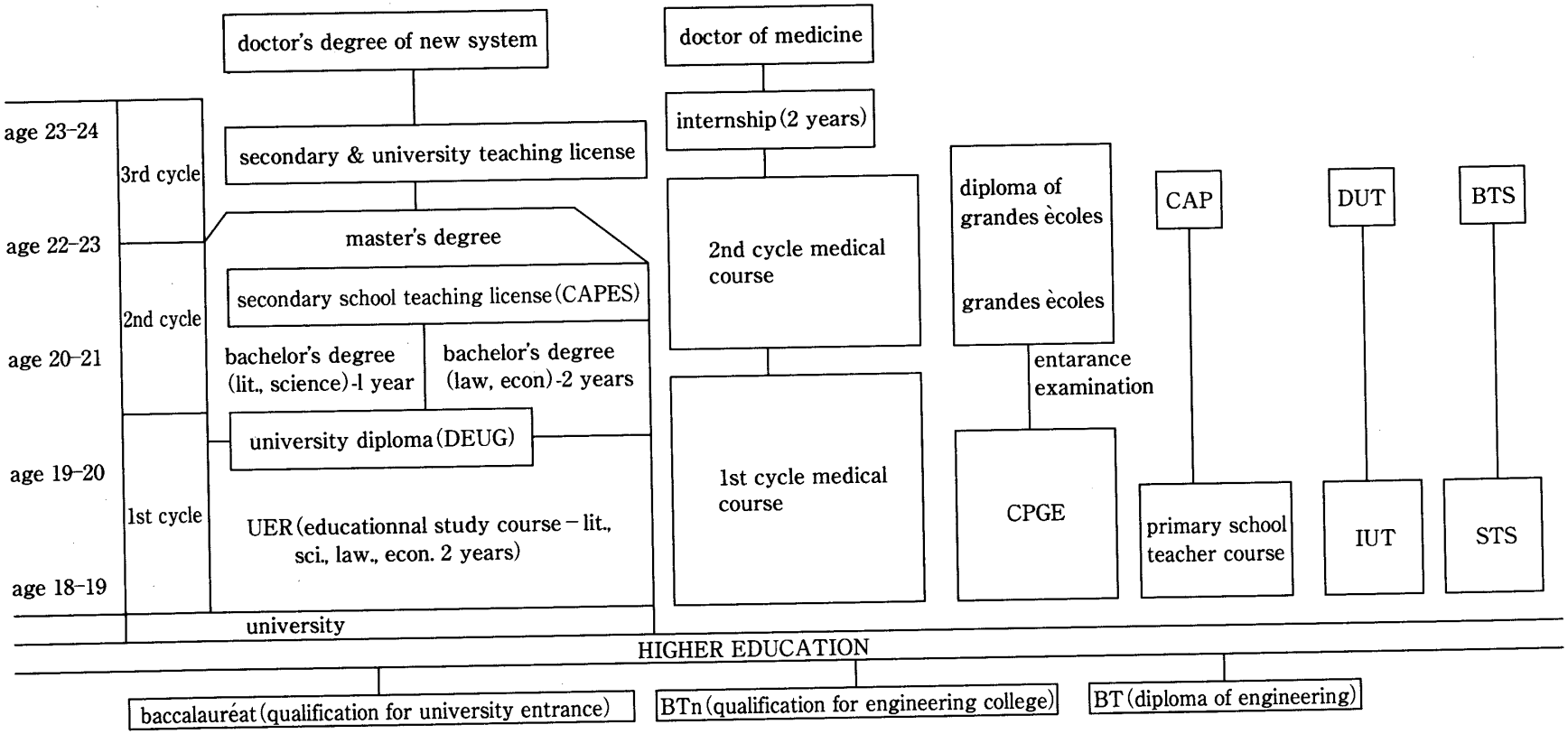
Note: 1998 data for Japan, and 1989 data for U.K.
Source: *White Paper on Science and Technology* (1993), Science and Technology Agency.
(Original source: *British Engineer and Japanese Engineer*, Japan Productivity Center.)

French Education System and Wage Differentials

To examine what type of human resource development is necessary for the future Japanese economy, we take France as the example. There are two aspects when we look at the characteristics of French education system. One is the variety of choices in educational background including occupational training, and the other is the existence of the occupational classes closely related to this educational background.

First, Figure 4 shows the variety of educational background in France. The education system in France before higher education is similar to that of Japan. Elementary and secondary education consists of 12 grades in total and ends at about

Figure 4. Organization of French Education (as of 1995)



Notes: CPGE—prep-school for grandes ècoles (1-3 years)
CAP—teaching certificate
DUT—diploma of engineering college
IUT—engineering college
BTS—certificate of advanced engineering

Source: *CROWN French-Japanese Dictionary* 3rd. edition, Sanseido, Tokyo (1990), updated with latest information according to Ministry of Education of France.

17 to 18 years old. Compulsory education is until 16 years of age and students can end their education at any grade. However, to enter higher education, a student must have a qualification called a baccalaureate. There are some other qualifications for students to proceed to higher education in the engineering field. BTn and BT are the qualifications for higher education in engineering. For lower levels of technicians, BEP (diploma of professional studies) or CAP (professional aptitude certificate) can be obtained after secondary education.

The system of higher education is significantly different from that in Japan. *Les grandes ecoles* are colleges of university level specializing in professional training, and are independent of the universities. Graduates from these colleges become the privileged class called *les cadre* in France. This is a very unique educational institution which tells us the history in the formation of social classes in France, and their contribution as the major supplier of talented managers and officers has been very large.

Universities give certificates in many fields of sciences according to years of

Table 5. Effect on Wages of Occupation—Category and Qualification—Classification

	manufacturing	construction	services
blue-collar	(standard)	(standard)	(standard)
unskilled 1	0	0	0
semi-skilled 2	3.2	0.3	2.8
〃 3	5.9	1.5	4.9
〃 4	10.5	5.7	10.0
skilled 5	16.5	8.5	13.2
〃 6	25.3	13.4	18.5
highly-skilled	33.7	22.8	25.6
white collar			
unskilled	10.0	18.1	3.0
semi-skilled	18.0	23.7	16.1
highly-skilled	36.6	46.8	29.8
section chief			
1st level	50.3	49.3	35.8
2st level	70.9	68.9	54.3
middle-class engineer			
standard	43.7	51.8	48.2
advanced	65.7	77.9	62.6
management & upper-class engineer			
beginner	119.8	129.4	108.1
intermediate	156.0	174.2	148.6
advanced	247.6	244.1	246.8

(standard) :wages as comparison standard.

Note: Annual income of salaried employee (age: 18-59) who worked full-time.

Source: Lhertier, Jean-Louis, "Les determinants du salaire". *Economie et Statistique,* LNSEE, 1992. (original source: INSEE, the questionnaire on the structure of the salaries in 1986)

education; general diploma (DEUG), bachelor's degrees and master's degrees. For a doctorate, several different categories exist: DESS (for occupational career after 1 year of education), DEA (for preparing research papers) and doctoral degree of new system (final doctoral degree).

Second, another aspect of the French education system is that these educational qualifications are closely related to occupational categories. For example, the required level of educational background for each classification of jobs is strictly described in the labor-management agreement of the metal industry. More precisely, no educational background is needed for the lowest level of jobs, lower secondary school plus 2 years for the next level of jobs, and lower secondary plus 2 to 3 years for the next, and so on. Accordingly, there is a significant relationship between educational background and occupational classes in France.

When analyzing the labor market in France, we often face the phrase "categorie socioprofessionelle." It can be translated directly as "socio-professional category." It is a sort of mixture of the category of occupation and the category of social class. For a rough example, these include "blue-collar," "white-collar," "middle-class engineer," "management and upper-class engineer (cadre)," "craftsman, merchant and self-employed" and "farmer." More precisely, the "blue-collar" and "white-collar" categories are divided into more detail according to the level of experience, and in the category of "management and upper-class engineer (cadre)," professionals, upper-class public servants, professors in higher education, scientists, journalists, artists and managers of private firms are included. The wage differentials among these categories are shown in Table 5. We can see from this table that French advanced managerial workers receive nearly 3.5 times the wages of unskilled blue-collar workers.

Management Skills and Wage Profiles

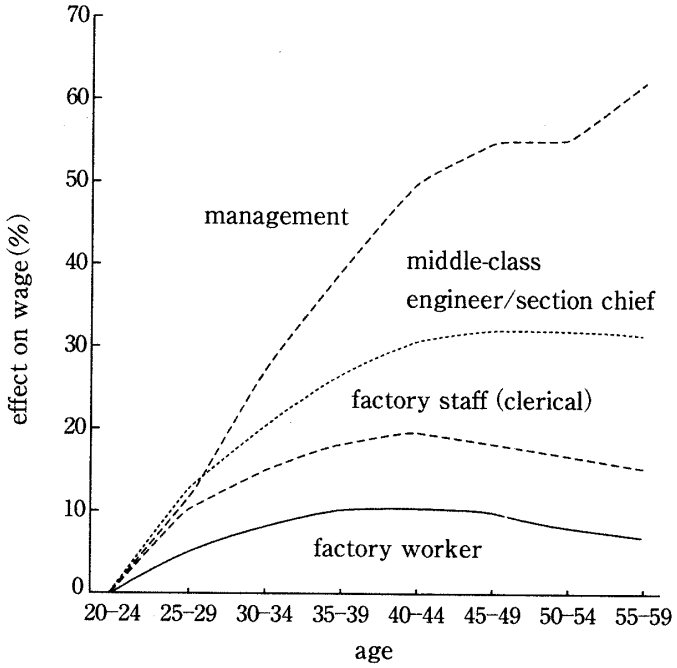
If we use the "socio-professional category," it would be easier to analyze the wage determination mechanism in France. There are large wage differentials among socio-professional categories as we have seen in Table 5. In addition to that, we can find some other characteristics in the wage profiles of French workers.

In Figures 5 and 6, we can observe that the age-wage profile of French managers increases as they get older, but does not increase as their experience in one company becomes longer. On the contrary, wages for production workers increase as their experience in the same company increases.

This shows that the skills of French managers (cadre) are not company-specific as is often seen in Japan, but are general, which makes it easy for managers to move from company to company. This suggests that for management, the external labor market is effective in France whereas the internal labor market is effective in Japan. In other words, managers are usually educated through a higher education system like *les grandes ècoles* which is independent of the specific environment of individual firms. This enables the flexible movement of managers in France.

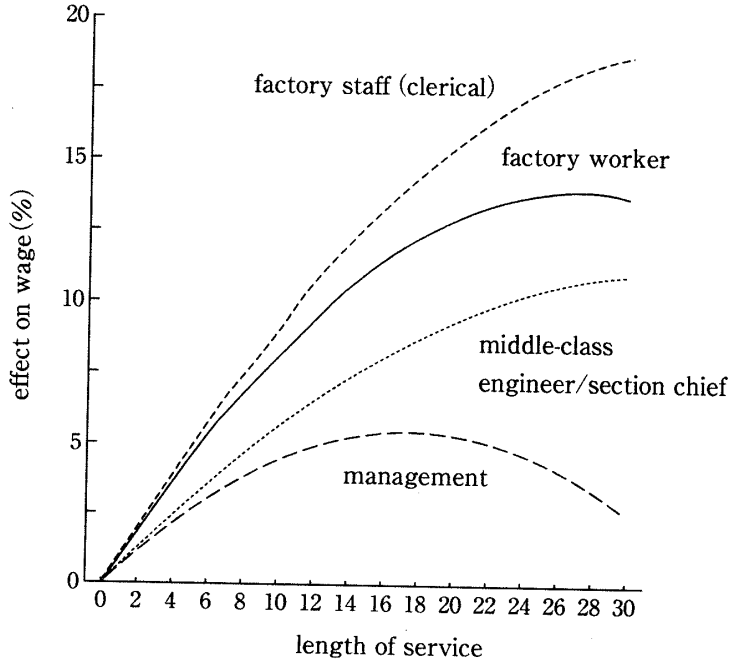
In Japan age-wage profiles are upward-sloping for management as well as production workers. This type of wage profile for blue-collar workers can not be seen in European countries. As Figures 5 and 7 show, the slopes for blue-collar workers in Japan are steeper than that for France, and the slopes for French managers are flatter in comparison to Japan, with regard to years of experience in the same company.

Figure 5. Effect of Age on Male Wage in Maunfacturing



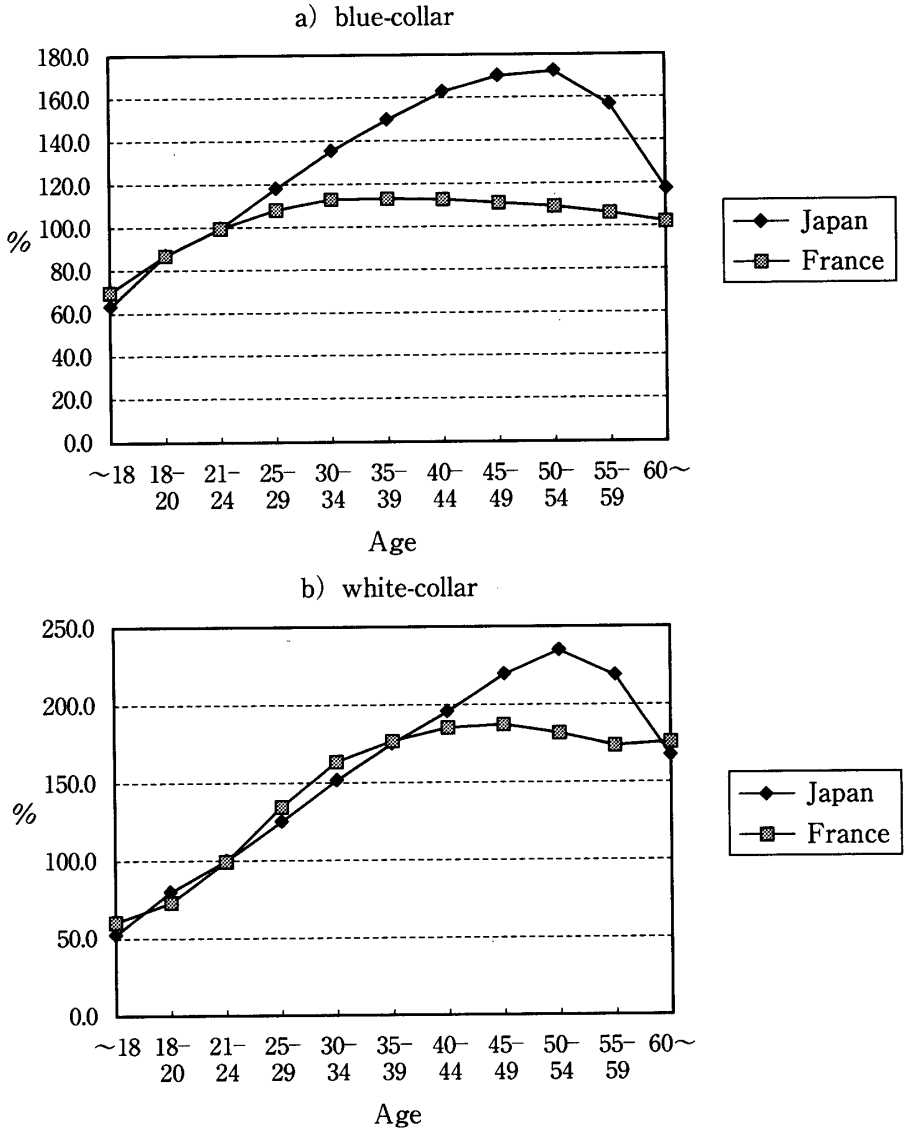
Source: Lhertier, Jean-Louis, "Les Dêterminants du Salaire", *Économie et Statistique*, INSEE, 1992.
(Original Source: INSEE, *L'enquete sur la structure de salaires* en 1986.)

Figure 6. Effect of Length of Service on Male Wage in Manufacturing



Note: Annual income of salaried employee(ages 18-59) who worked full-time.
Source: Lhertier, *ibid.*

Figure 7. Japan-France Comparison of Wage Differentials by Age (manufacturing industry: male worker, age 21-24=100)



Notes: 1993 data for Japan; 1972 data for France.
Source: Practical Labor Statistics (1996, Japan Productivity Center for Socio-Economic Development)

Conclusion

Under two hypotheses, we observed the role of universities in technological development and human resource development. We have seen that universities are not only the source of human resources but also the center of the human resources network. Universities must increase their research and education capability for technological development. Although their budgets are low, the functional role of universities in networking will continue to be important.

There are two implications from this France-Japan comparison of human resource development for technological development. One is the need for an overall strategic view of human capital formation in coordination with the strategy for technological development. Especially for the high technology and urban development technology fields, resources need to be intensified in selected projects. As we have seen in this paper, the French system is more suitable for this type of technological development.

The second implication is that the government should offer a precise and organized system of education and occupational skills with closer links to social and business organizations. This may become the target of human capital investment for workers looking for new jobs in the external labor market. The Japanese internal promotion system worked very well in providing guidelines to workers about which skills should be learned and when. It also worked very well for guaranteeing workers a return on their human capital investment as long as they were employed within the same internal labor market. However, the new condition of the Japanese labor market is characterized by more unstable employment to cope with unstable economic conditions.

More interactive and harmonized relationships between higher education and training in firms are needed. This will lead to a more strategically organized technological and human resource development policy.

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