Section 2 Securing highly-skilled professionals and creating innovations

Japan’s external economic relationships tend to be heavily tilted toward particular regions, countries and product items. In order to broaden the foundation of such relationships, it is necessary to recognize trends at new global frontiers, and it is also essential for Japanese companies to take on new challenges in view of the recognized trends.

Meanwhile, as the shift in industrial structure to the platform business is ongoing in line with the advance of information and communications technology, the platform business is expected to become a pillar of future economic growth achieved through innovation. Along with business strategies, human resources are important for promoting the platform business, and competition to secure competent highly-skilled professionals, particularly those in the IT sector, is intensifying across national borders.

This section will describe the situation of highly-skilled professionals and challenges and consider the necessity of innovation (technological innovation) in order to broaden the foundation of Japanese industries. Subsequently, the relationship between the international movement of human resources and innovation will be examined in order to obtain suggestions for broadening the foundation of Japan’s external economic relationships.

1. Securing of highly-skilled professionals by Japanese industries

Here, we will consider the status of and challenges for securing highly-skilled professionals who contribute to the creation of innovations in order to enable Japanese industries to adapt to new global changes.

There are two ways to increase highly-skilled professionals in Japan: one is attracting such workers from abroad and the other is keeping highly skilled Japanese professionals in the country. In this paragraph, we will examine challenges for attracting and encouraging highly-skilled foreign professionals to stay in Japan for the long term in “(1) Trends related to highly-skilled foreign professionals and enhancement of efforts to attract such workers.” In “(2) Securing IT-skilled workers for whom needs are growing across national borders and challenges,” we will examine challenges for securing IT-skilled workers in order to explore new global frontiers, such as the platform business, with a particular focus on highly-skilled professionals in the IT sector, who may contribute to the creation of innovations.

(1) Trends related to highly-skilled foreign professionals and enhancement of efforts to attract such workers

As was mentioned earlier, the need for highly-skilled professionals is growing in Japan, so securing such workers has emerged as a challenge. In particular, it is argued that highly-skilled foreign professionals contribute to Japanese companies’ overseas strategies and that their interactions with

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14 In this section, “highly-skilled professionals” refer to workers who have acquired professional skills and knowledge, including both Japanese and foreign nationals. On the other hand, highly-skilled professionals from abroad in particular are referred to as “highly-skilled foreign professionals.”

15 “Highly-skilled professionals are defined in various ways in countries around the world. Under Japan’s Points-based System for Highly Skilled Foreign Professionals, highly-skilled foreign professionals are defined as “human resources who are expected to bring innovation to the Japanese industries, to promote
Japanese workers will provide the impetus for new innovations. Therefore, in Japan, it is considered to be important to promote the attraction of foreign workers with a high level of professional knowledge and skills, thereby securing high-quality human resources from around the world.\textsuperscript{16}

In this paragraph, we will review the current situation of highly-skilled foreign professionals in Japan while comparing it with the situation in other major countries. At the same time, we will examine efforts by Japanese tertiary education institutions to attract foreign students. In the case of foreign students at tertiary education institutions, it is not only guaranteed that they have a certain level of knowledge, but they are in a favorable environment for acquiring Japanese language proficiency and understanding Japanese culture, so it is presumed that it is relatively easy to encourage them to stay in Japan after graduation. Therefore, promoting efforts to attract foreign students and encourage them to stay in Japan after graduation is highly likely to increase highly-skilled foreign professionals in Japan.

(A) Trends related to highly-skilled foreign professionals in Japan

(a) Trends related to efforts to attract and encourage highly-skilled foreign professionals to stay in Japan

Here, we will look at trends related to highly-skilled foreign professionals in Japan while comparing them with trends in other countries.

The definition of highly-skilled foreign professionals differs from country to country. In many countries, academic achievement equivalent to the completion of tertiary education is a criterion for highly-skilled foreign professionals. The OECD uses academic achievement equivalent to the completion of tertiary education (ISCED 5 or higher) as a criterion when conducting an international comparison concerning highly-skilled foreign professionals, so we conduct our comparison in line with that approach.

Figure II-1-2-1 shows changes in the ratio of the inflow of workers who have completed tertiary education to the population in major countries. The inflow of such workers tends to be concentrated in English-speaking countries like the United States and the United Kingdom, where language barriers are low, while the ratio of such workers are also increasing in non-English-speaking countries such as Germany and France. Compared with the ratios in these non-English-speaking countries, the ratio in Japan, also a non-English-speaking country, is low.

\textsuperscript{16} Since the first half of the 2000s, calls from industries for promoting the receiving of foreign workers have grown. In a report titled “Aiming to Make Japan A Vigorous and Attractive Country” (2003) by the Japan Business Federation and the “Report on Receiving of Foreign Workers” (2008) by the Japan Chamber of Commerce and Industry, the importance of attracting foreign workers, particularly highly-skilled foreign professionals, was pointed out. In addition, in the Japan Revitalization Strategy (Revised 2015), which was determined by the Cabinet on June 30, 2015, it was mentioned that priority should be placed on receiving competent foreign workers, particularly IT-skilled workers, from the viewpoint of promoting innovation through the integration of cutting-edge foreign knowledge with top-level domestic knowledge.
Figure II-1-2-1  (Reshown) Changes in the ratio of the inflow of workers who have completed tertiary education to the population

Note: Figures for Japan are calculated based on the number of workers who have not obtained Japanese nationality.
Source: DIOC 2005/06 and DIOC 2010/11

(b) Trends in attracting and encouraging foreign students to stay in Japan

Next, looking at the status of efforts to attract foreign students, who may be regarded as future highly-skilled foreign professionals, it is clear that English-speaking countries such as the United States and the United Kingdom are popular among foreign students and are main destinations for them. As in the case of efforts to attract highly-skilled foreign professionals, the number of foreign students received is also at a high level in non-English-speaking countries such as Germany and France, and the number is increasing in China and the ROK as well. In Japan, although the number of foreign students received is increasing moderately, it is lower than the levels in France and Germany (Figure II-1-2-2).
Figure II-1-2-2  Changes in the number of foreign students in major countries

![Graph showing the changes in the number of foreign students in major countries from 2004 to 2013.](image)

Note: The number of foreign students at tertiary education institutions is counted.
Source: OECD.Stat and Education at Glance

Meanwhile, the proportion of foreign students at Japanese universities who obtained a job in Japan after graduation fell to around 22% among the foreign students who graduated in academic year 2009 (who graduated in March 2010), immediately after the outbreak of the global economic crisis, but the figure rose to around 28% among the graduates in academic year 2013 (who graduated in March 2014), indicating a recovery in Japanese companies’ need to employ foreign students (Figure II-1-2-3). However, this figure is low compared with the peak of around 46% recorded in academic year 2006.
In a questionnaire survey conducted on foreign students at Japanese universities, 70.1% expressed a desire to obtain a job in Japan when asked about their future career. Compared with 2005, when the survey was conducted for the first time, the proportion of foreign students desiring to obtain a job in their home country or in a third country is on a downtrend, indicating that more and more students are eager to work in Japan. In the previous paragraph, an uptrend in the employment of foreign workers by Japanese companies was indicated, but a much larger number of foreign workers desire to find a job in Japan, suggesting that Japan is failing to seize the chance to secure high-quality human resources (Figure II-1-2-4).

Note: Students whose career path is unknown are excluded from the total number of foreign graduates when calculating the employment rate.

Source: “Results of the Survey on Career Path and Conferment of Degrees for Foreign Students” (Japan Student Services Organization)
Figure II-1-2-4  Foreign students’ desired career path after graduation (area of employment)

Note: Multiple answers allowed. This survey covers regular undergraduate students.
Source: “Survey on the Facts Concerning Privately-Financed Foreign Students’ Lives” (Japan Student Services Organization

(B) Factors to be considered in order to enhance the capacity to attract human resources

The current situation in Japan as shown above means that Japan’s capacity to attract highly-skilled foreign professionals and foreign students is low compared with other major countries’ capacity. Furthermore, regarding foreign students’ willingness to stay in Japan after graduation, although the number of students staying after graduation is on an uptrend, the proportion of students who obtain a job in Japan is growing only slightly and has not recovered to the level before the global economic crisis. In light of foreign students’ eagerness to obtain a job in Japan, Japan may be failing to seize the chance to secure high-quality human resources. While a variety of factors have been examined as possible causes of Japan’s low capacity to attract human resources, in this paragraph, we will consider the following three points: Japan’s residency status system for foreign nationals, Japanese companies’ systems for receiving foreign workers, and a lack of efforts to attract workers with science and engineering skills required by Japanese companies.

(a) Residency status system for foreign nationals

17 In “FY 2005 Program, etc. to Strengthen the Asian Industrial Foundation (Survey Research Intended to Promote Internal Globalization), an FY 2005 survey commissioned by the Ministry of Economy, Trade and Industry, challenges related to keeping highly-skilled foreign professionals and foreign students in Japan and measures to resolve them were discussed with input from hearings held with Japanese companies and highly-skilled foreign professionals. In the discussion, in addition to the above-mentioned factors, factors related to the living environment were also considered.

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In 2012, Japan developed a residency status system for foreign nationals, called the Points-based System for Highly Skilled Foreign Professionals, which provides a variety of preferential treatments to highly-skilled foreign professionals based on points granted according to such criteria as annual income and academic achievement. The objective of this system was to promote the attraction of highly-skilled foreign professionals, but called for improving the system grew because the number of its users increased only slightly. In 2013, the annual income criterion was revised, and additional points were granted in the case of highly-skilled foreign professionals working for small and medium-size enterprises receiving innovation promotion support from the government. In 2015, the “Highly Skilled Professional,” a residency status category that exclusively covers highly-skilled professionals, was created and it was so arranged to allow workers who have stayed in Japan for three years under the status of “Highly Skilled Professional (i)” to shift to the status of “Highly Skilled Professional (ii),” which grants the right to stay in Japan for an indefinite period of time as “permanent residents” are allowed to do.

The cumulative number of the system’s users was 4,300 workers as of December 2015, and the government aims to increase the number to 5,000 by the end of 2017.

As for other countries’ policies for attracting highly-skilled foreign professionals, Germany is operating a residency status system called the EU Blue Card, which is presumed to be promoting the attraction of highly-skilled foreign professionals and foreign students because it makes it easy to obtain permanent residency.

Under these circumstances, Japan will develop immigration and residency management systems that are more attractive than other countries’ systems, for example by establishing a Japanese version of the Green Card for highly-skilled foreign professionals, which will be among the fastest-track permanent residency systems in the world. At the same time, Japan will attract more highly-skilled foreign professionals by promoting the use of the Points-based System for Highly Skilled Foreign Professionals, supporting the matching of foreign nationals desiring to work in Japan (foreign students in Japan, students at foreign universities eligible for support under ODA programs to develop high-quality human resources, foreign nationals who have completed the JET program, etc.) with companies eager to employ foreign workers and improving the living environment, including the education environment for children of foreign workers in Japan.

On the other hand, Japan’s Points-based System for Highly Skilled Foreign Professionals provides superior preferential treatment than other countries’ systems in some aspects, such as allowing workers to bring their parents with them to Japan if certain conditions are met.

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18 Under the system, highly skilled professionals are defined as follows: “The quality, unsubstitutable human resources who have a complementary relationship with domestic capital and labor,” and “the human resources who are expected to bring innovation to the Japanese industries, to promote development of specialized/technical labor markets through friendly competition with Japanese people and to increase efficiency of the Japanese labor markets.” (Report of the Council for the Promotion of Acceptance of Highly Skilled Professionals dated May 29, 2009.)

19 For the details, refer to “Part II, Chapter 3, Section 2 Use of Highly-skilled professionals in Germany” of this white paper.

20 Refer to the reference materials at the seventh meeting of the Council on Economic and Fiscal Policy (April 25, 2016).
so it is necessary to actively publicize measures that have strong appeal\(^2\) (Table I-2-5).

### Table I-2-5 Systems to attract highly skilled foreign professionals

<table>
<thead>
<tr>
<th>Country</th>
<th>System</th>
<th>Type of visa</th>
<th>Points-based System</th>
<th>Policies concerning foreign students</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>Green Card</td>
<td>Permanent residency</td>
<td>USA has programs to attract highly skilled workers, including the H-1B visa for specialty workers and the O-1 visa for those who possess extraordinary abilities.</td>
<td>UK or Canada has programs to attract highly skilled workers, including the Global Talent visa.</td>
</tr>
<tr>
<td>Germany</td>
<td>Blue Card/Visa System</td>
<td>Skilled workers</td>
<td>Germany has a Blue Card system to attract highly skilled workers.</td>
<td>Switzerland has a Blue Card system to attract highly skilled workers.</td>
</tr>
<tr>
<td>UK</td>
<td>Visa System</td>
<td>Skilled workers</td>
<td>UK has a visa system to attract highly skilled workers.</td>
<td>Canada has a similar system to attract highly skilled workers.</td>
</tr>
<tr>
<td>ROK</td>
<td>Points-based System</td>
<td>Skilled workers</td>
<td>ROK has a points-based system to attract highly skilled workers.</td>
<td>Japan has a points-based system to attract highly skilled workers.</td>
</tr>
</tbody>
</table>

Source: “2014 Report on Overseas Situation” (MHLW), “Survey on the Outlining of Foreigners Admission Systems in Other Countries and Discussions Concerning the Influence of These Systems” (JILPT), “Brain Gain/Circulation Policy and International Student Policy in Korea: In Light of its Migration Policy and Implications for Japan” (Yuriko Sato), MOJ website, and material by JASSO

### (b) Negative perception of the working environment in Japan

One of the important factors concerning efforts to encourage highly-skilled foreign professionals to stay in Japan for the long term is the working environment for them. Here, we will examine challenges related to working in Japan.

According to a questionnaire survey conducted on foreign nationals with the experience of working for Japanese companies in Japan on a full-time basis, 81.7% replied that they had a positive view of living in Japan, whereas only 21.1% regarded working in Japan as an attractive idea. Furthermore, when asked about factors behind their negative perception of working in Japan, the respondents cited factors such as long working hours, late promotion, and a lack of transparency in the evaluation system.

\(^{2}\) Refer to the reference materials at the second meeting of the working group on the study of issues related to receiving foreign nationals under the sixth policy consultation council on immigration control (May 1, 2013).
indicating their dissatisfaction with a personnel management system with unique Japanese characteristics (Figures II-1-2-6 and II-1-2-7).

Figure II-1-2-6  Foreigners’ view on living and working in Japan

Note: The above figure shows answers from respondents who have experienced working full time at a Japanese company.
Source: The results of a survey by the Japan Association for Promotion of Internationalization (JAPI)
Note: The above figure shows answers from respondents who have experienced working full time at a Japanese company.

Source: The results of a survey by the Japan Association for Promotion of Internationalization (JAPI)

In response to a free-answer question, some respondents cited items not included among the reply options in the questionnaire survey, such as a slow pace of wage increase. Regarding the average wages in Japan and major European countries, a chart of indicators using the average wage of workers aged 29 or younger (at companies with a workforce of at least 10 employees) as the base figure of 100 shows that the wages in the United Kingdom and Germany rise earlier (Figure II-1-2-8).
Figure II-1-2-8  Average wages by age group in Japan and major Europe countries

Note: Figures for Europe and those for Japan were calculated based on Monthly Earnings and the amount of regular wages in June, respectively. Data is from 2010 for the former and 2015 for the latter. Source: “Basic Survey on Wage Structure” (Ministry of Health, Labour and Welfare) and Eurostat

(c) Shortage of human resources required by companies

Next, we will examine whether Japan is adequately attracting the types of human resources required by Japanese companies.

Figures II-1-2-9 and II-1-2-10 show the composition of foreign students at Japanese tertiary education institutions by nationality and by major (2013). By major, students majoring in humanities (21%) and social sciences (38%) together account for some 60% of the total, while students majoring in science-related subjects, including sciences (2%), engineering and architecture (17%) account for around 20%. By nationality, students from Asia account for 92.2%, followed by students from Europe (3.4%) and from North America (2.1%). Among the students from Asia, Chinese students constituted the largest group with a share of 65.3% (Figures II-1-2-9 and II-1-2-10).
Figure II-1-2-9  Composition of foreign students in Japan [by nationality]
(By nationality)

Source: OECD.Stat

Figure II-1-2-10  Composition of foreign students in Japan [by major]
[By major]

Source: OECD.Stat

Figure II-1-2-9 shows that Chinese students account for most of the foreign students in Japan. Below, we will show in which countries Chinese students are studying based on a white paper on returned Chinese foreign students.\(^{22}\) According to the white paper, among Chinese students at the undergraduate

\(^{22}\)Refer to the white paper on returned Chinese foreign students (Ministry of Education of China).
level, the ROK, the United Kingdom and the United States are popular as destination countries, and among students at the master’s degree level, the United Kingdom, the United States and Australia are popular. However, at the doctoral level, Japan, along with the United States, is attracting many Chinese students. As this survey is conducted on Chinese people who have returned to China after graduation, it must be taken into consideration that some students have obtained a job in the country where they studied or in a third country, but it is nevertheless useful as a reference. Since the 1990s, the Chinese government is implementing the policy of encouraging Chinese foreign students to return to and work in China after graduation. As a result, around 79.9% of Chinese foreign students return to China after graduating abroad.

As is shown in the case of China, countries’ efforts to secure highly skilled workers include encouraging students who have studied abroad to return home. The trend of foreign students returning to their home countries after graduation may affect Japan’s efforts to encourage them to stay in Japan, so it is necessary to step up these efforts (Figures II-1-2-11, II-1-2-12 and II-1-2-13).

Figure II-1-2-11  Foreign study destinations for Chinese students (undergraduate students, etc.)

Note: Limited to the students who have returned to China after studying abroad
Source: “中国留学回国就业蓝皮书 2015” (Chinese Service Center for Scholarly Exchange)
Next, we will examine possible factors behind Japan’s low capacity to attract highly-skilled foreign professionals from the viewpoint of the composition of foreign students by major. Regarding the trends in Japanese companies’ employment of foreign students, 32.7% intend to employ foreign students studying humanities at Japanese universities and graduate schools immediately as new graduates, while
34.0% intend to employ foreign students studying sciences, meaning that demand for students with sciences skills is slightly higher, so it is desirable to promote the attraction of foreign workers with science skills (Figure II-1-2-14).

![Figure II-1-2-14 Routes of recruitment of foreign workers](image)

Source: “FY2014 Research Project Commissioned by the Ministry of Economy, Trade and Industry (Survey on the Employment and Settlement of Foreign Students)” (Ernst & Young ShinNihon LLC)

(C) Summary

Above, we showed that Japan’s capacity to attract and encourage highly-skilled foreign professionals to stay for the long term is low and explained three presumed factors impeding the attraction of such workers.

As was mentioned in Section 1, the number of foreign visitors to Japan is trending upward, and the number of foreign students is also on the rise as shown above. On the surface, the globalization of human resources appears to be proceeding. However, by the global standard, the level of globalization of human resources in Japan is low, so there is presumably room for improvements. As Japanese companies need to strengthen their international competitiveness and innovation capability, it is desirable that the public and private sectors work together to promote such initiatives as developing a working environment that makes it easier for highly-skilled foreign professionals to stay in Japan for the long term and reforming institutional systems in order to enhance Japan’s capacity to attract such workers.

In the next paragraph, we will examine efforts to secure IT-skilled workers in order to strengthen the innovation capability. As shown by the explanations concerning the three factors in this paragraph, demand for workers with sciences skills is high. We will consider the challenges faced by Japan, which is required to secure human resources that underpin Japanese industries.
(2) Securing IT-skilled workers for whom needs are growing across national borders and challenges

In order to broaden the foundation of Japanese businesses by utilizing the evolving information and communications technology and promoting global expansion of various innovative businesses, including the digital platform business, which form the new global frontier as shown in Chapter 1, there are growing needs for human resources that enable such activity. Meanwhile, it is said that Japan is facing a shortage of engineers and technical workers capable of connecting IT with business or developing advanced programs. Below, we will focus attention on IT-skilled workers. In order to attract a cluster of IT-skilled workers to Japan, we will look at the evaluation of the employment environment in Japan and challenges that can be learned from initiatives of Japanese companies which have expanded into the Silicon Valley, which is a cluster of cutting-edge IT technology.

(A) Growing international needs for IT-skilled workers

In order to promote global expansion of new businesses, including the digital platform business, by utilizing information and communications technologies that have evolved in recent years, including IoT, big data and artificial intelligence, the presence of IT-skilled workers capable of developing advanced programs is essential. According to a survey conducted by Mckinsey, IT-skilled workers are concentrated particularly in the United States, where there are clusters of globally competitive IT companies, and in recent years, the number of IT-skilled workers has also increased significantly in China, which is reforming the economic structure in order to shift to services (Figure II-1-2-15).

Figure II-1-2-15 Changes in the number of workers with analytical talent

![Graph showing changes in the number of workers with analytical talent from 2004 to 2008 for various countries, including the United States, China, India, Russia, Brazil, Poland, United Kingdom, France, Romania, Italy, and Japan. The graph indicates compound annual growth rates and the number of workers in thousands.](image-url)
On the other hand, a shortage of workers with advanced IT skills and the ensuing wage rise have been pointed out in the United States, too.24 Mergers and acquisitions are also used in order to secure IT-skilled workers who are essential to digital businesses. In particular, there is an increasing number of cases around the world in which companies with workers possessing unique, innovative skills are acquired at a high price (Table II-1-2-16).

<table>
<thead>
<tr>
<th>Company name</th>
<th>Main products</th>
<th>Date of acquisition</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCHAFT (Japan)</td>
<td>Humanoid robot</td>
<td>December 2013</td>
<td>The University of Tokyo’s first venture business. The company won the first prize at Robotics Challenge held by the Defense Advanced Research Projects Agency (DAPRA).</td>
</tr>
<tr>
<td>Industrial Perception</td>
<td>Robot arm</td>
<td>December 2013</td>
<td>A manufacturer of industrial robots for logistics, such as automated truck unloaders. A spinoff from Willow Garage, which is famous for its robot operating system.</td>
</tr>
<tr>
<td>Redwood Robotics (US)</td>
<td>Robot arm</td>
<td>December 2013</td>
<td>A joint venture of Willow Garage and other companies. The company aims to develop economic and safe robot arms.</td>
</tr>
<tr>
<td>Meka Robotics (US)</td>
<td>Robot</td>
<td>December 2013</td>
<td>A spinoff venture from the MIT Computer Science and Artificial Intelligence Laboratory. Development of biped robots, etc.</td>
</tr>
<tr>
<td>Holomni (US)</td>
<td>Robot</td>
<td>December 2013</td>
<td>Development of robotic vehicles that are able to move toward multiple directions.</td>
</tr>
<tr>
<td>Boston Dynamics (US)</td>
<td>Robot</td>
<td>December 2013</td>
<td>A spinoff from MIT. Development of humanoid and animal-like robots.</td>
</tr>
<tr>
<td>Nest (US)</td>
<td>Home automation</td>
<td>January 2014</td>
<td>Manufacturing of thermostats and fire alarms. Function as a hub for smart homes. The</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company</th>
<th>Technology</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeepMind Technologies</td>
<td>AI</td>
<td>January 2014</td>
<td>Development of AI that can learn to play video games by reinforced learning.</td>
</tr>
<tr>
<td>Jetpac (US)</td>
<td>AI</td>
<td>August 2014</td>
<td>Tour guide application utilizing big data analysis, image processing and machine learning.</td>
</tr>
<tr>
<td>Dark Blue Labs (UK)</td>
<td>AI</td>
<td>October 2014</td>
<td>Natural language processing utilizing deep learning technologies.</td>
</tr>
<tr>
<td>Vision Factory (UK)</td>
<td>AI</td>
<td>October 2014</td>
<td>Image recognition systems utilizing deep learning technologies.</td>
</tr>
<tr>
<td>Revolv (US)</td>
<td>Home</td>
<td>October 2014</td>
<td>Manufacturing of hardware that works as the hub of connected homes (linking domestic devices).</td>
</tr>
<tr>
<td>Tilt Brush (US)</td>
<td>3D printer</td>
<td>April 2015</td>
<td>Painting on a virtual 3D space using VR headsets.</td>
</tr>
<tr>
<td>Timeful (US)</td>
<td>AI</td>
<td>May 2015</td>
<td>The company’s AI provides users with optimized behaviors and deepens its learning utilizing machine learning technologies.</td>
</tr>
</tbody>
</table>

Source: Material by the secretariat for the New Industrial Structure Committee, Industrial Structure Council, METI (third meeting)

(B) Growing needs for IT-skilled workers in Japan

In Japan, too, both IT user companies and IT companies are acutely feeling a shortage of IT-skilled workers.

According to the *White Paper on IT Human Resources 2015*, a questionnaire survey concerning the sense of excess or shortage of IT-skilled workers found not only that there was a widespread sense of shortage among user companies such as manufacturers but also that around 90% of IT companies were feeling a shortage (Figure II-1-2-17).
Companies’ view on the supply of IT workers

Note: Companies whose main customers are both IT and business departments, or management, or others, and companies that did not respond are excluded.

Source: The results of the survey in “White Paper on IT Human Resources 2015” (Information-technology Promotion Agency)

Moreover, regarding workers capable of creating new businesses and services through innovation in the area of integration of IT and business that is presumed to be essential to promoting the platform business (workers with IT integration skills), less than half recognized the need for such workers and the achievement in securing such workers was low (Figure II-1-2-18).

Need for and securing of workers with IT integration skills at IT companies and user companies

Source: The results of the survey in “White Paper on IT Human Resources 2015” (Information-technology Promotion Agency)
Below, we will conduct international comparison regarding the employment environment for IT engineers for whom international needs are growing as a factor for attracting them to Japan from abroad based on a questionnaire survey conducted, on commission from the Ministry of Economy, Trade and Industry, on IT engineers in Japan, the United States, India and China, among other countries.

In order to identify what elements of the working environment IT engineers living in the United States, India, China and Japan, which may be regarded as advanced IT countries, considered to be important, let us look at the factors to which they attach importance when switching jobs. “Salary” was the most appreciated factor among IT engineers in all of the four countries. As for other factors, IT engineers in Japan showed a different tendency from their counterparts in other countries, but “position, rank and gravity of responsibility,” “future potential of the company,” “sense of job satisfaction” and “skill improvement” were appreciated by 20% to 40% by IT engineers in the United States, India and China (Figure II-1-2-19).

![Figure II-1-2-19 Factors to which IT engineers attach importance when switching jobs](image)

Note: Country names indicate respondents’ place of residence.  
Source: “International Comparative Research on IT Workers” (METI)

Next, in order to check the assessment of the actual employment environment, we will compare IT engineers in Japan and the United States with respect to the level of satisfaction with their jobs and workplace environment. In the case of IT engineers in the United States, around 50% expressed satisfaction regarding many items related to jobs and the workplace environment, while the level of

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25 “International Comparison Survey Concerning IT-Skilled Workers” an FY2016 survey commissioned by the Ministry of Economy, Trade and Industry.
satisfaction regarding all items was significantly low among IT engineers in Japan\(^{26}\) (Figure II-1-2-20).

**Figure II-1-2-20  Level of satisfaction with the current jobs and workplace environment**

![Diagram showing levels of satisfaction with various aspects of work.](image)

Note: Country names indicate respondents’ place of residence. Figures show the percentage of workers who responded that they are satisfied concerning each item.

Source: “International Comparative Research on IT Workers” (METI)

Of the criteria used by IT engineers for assessing the employment, let us look at the distribution of the level of “salary” among the survey sample by class of position. In the United States, salaries are generally high, although the salary distribution is relatively dispersed, among IT engineers in both the “senior management and executive class” and the “rank-and-file worker class.” In India, it is notable that while salaries are generally low, some IT engineers earn a high level of salaries. On the other hand, in Japan, a bias toward a certain salary level (around 9 million to 15 million yen for the senior management and executive class and the division head class and around 3 million to 5 million yen for the rank-and-file worker class) is larger than in other countries: in other words, although salaries in Japan are higher than the lowest levels in China and India, they are concentrated at lower levels than in the United States (Figure II-1-2-21).

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\(^{26}\) In the questionnaire survey cited here, respondents were asked to select replies from among four options—“satisfied,” “more or less satisfied,” “more or less dissatisfied” and “dissatisfied”—with respect to 10 items, including “the atmosphere of the workplace” and “the contents of the job” in addition to the items indicated in Figure II-1-2-20.
Figure II-1-2-21  Annual income distribution among the respondents
(Senior management and executive class and the division head class)

Note: The horizontal axis shows wage level and vertical axis the distribution of respondents that fall under each wage level. The figure was created using kernel density estimation, which approximates frequency distribution by a continuous function. Country names indicate respondents’ place of residence.
Source: “International Comparative Research on IT Workers” (METI)

Regarding the “career prospects within the company,” we will look at the job rank of IT engineers, a factor which may provide clues for a future career path for them. In the United States and other
countries, around 40% to 50% are in positions of responsibility for a broad range of business activities, such as the senior management and executive class and the division head class, but in Japan, around half are in the rank-and-file worker class and only around 10% are in senior positions, such as the senior management class (Figure II-1-2-22).

![Figure II-1-2-22  Job rank of respondents](image)

Note: Country names indicate respondents’ place of residence.
Source: "International Comparative Research on IT Workers" (METI)

As shown above, the conditions in Japan are inferior to those in other countries with respect to “salary” and “position, rank and gravity of responsibility,” which are elements of the working environment considered to be important by IT engineers in the countries. These findings indicate that IT engineers in Japan receive unfavorable treatment compared with their counterparts in other advanced IT countries, with the result that their level of job satisfaction is generally low; in other words, the attractiveness of the job itself is low. Presumably, this situation is causing a shortage of workers with IT integration skills, who are high-quality human resources capable of creating new businesses and services, thereby obstructing the creation of competitive products and services.

Next, regarding the performance evaluation, a factor that may enhance worker motivation and create a sense of job satisfaction, we will look at the items which engineers think are appreciated in the workplace. In Japan, many items were cited by only a small proportion of IT engineers. In the United States, high productivity and contribution to customers in particular are presumed to be appreciated as elements of the quality of job performance. However, the survey results show that in Japan, more than those items, items that are considered to be important elements of a member of the organization, such as the level of trust gained from seniors, are appreciated (Figure II-1-2-23).
Finally, “in-house education and training and support for self-improvement,” along with the contents of the job, are presumed to be major factors as to whether employees can improve their skills.

Participation in training is promoted by employees’ strong needs in the first place, so let us look at the correlation between the level of the recognition of the necessity for IT engineers to strive and study, as represented by the percentage of respondents who chose the reply “fit the description well” in response to a relevant question, and the frequency of participation in training. We can see that there is a positive correlation with the frequency of participation in training. In particular, both the level of recognition of the necessity and the frequency of participation are high among IT engineers in the United States and India\(^27\) (Figure II-1-2-24).

---

\(^{27}\) The need for self-improvement is presumed to be also affected by various factors, including the skill level required of employees and a management system that provides motivation for self-improvement.
Figure II-1-2-24  Elements related to the frequency of participation in training (recognition of necessity)

Note: Country names indicate respondents’ place of residence.
The recognition of necessity shows the percentage of respondents that replied “fit the description well.”
The frequency of participation in training shows the percentage of respondents that participate in training
a few times a week.
Source: "International Comparative Research on IT Workers" (METI)

Meanwhile, participation in training is presumably constrained by working hours, so we will look at
the correlation between the “level of satisfaction with working hours,” an item which may be useful for
estimating such constraints, and the frequency of participation. We can see that there is a positive
correlation between these two items, and among IT engineers in the United States and India, the level
of satisfaction with working hours and the frequency of participation in training are high. On the other
hand, the correlation between the two items is weaker in Japan than even in China and the ROK,
indicating the possibility that Japan is inferior to other countries in terms of not only the employment
environment but also the skill improvement opportunity (Figure II-1-2-25).
Figure II-1-2-25  Elements related to the frequency of participation in training (level of satisfaction with working hours)

Note: Country names indicate respondents’ place of residence.
The level of satisfaction with working hours shows the percentage of respondents who reported that they are satisfied. The frequency of participation in training shows the percentage of respondents that participate in training a few times a week.
Source: "International Comparative Research on IT Workers" (METI)

If we look at the reasons why IT engineers in the United States, India, China and Japan desire to work abroad in order to identify the needs of workers whom countries are trying to attract relative to their current employment environment, we can see that “salary” is appreciated by many IT engineers in this case again, but “skill improvement” and “satisfaction with and interest in the job” are also appreciated by many (Figure II-1-2-26).
The United States, where major IT companies are concentrated and whose employment environment is highly evaluated as shown earlier, is the most popular foreign country to work in among IT engineers if they are to switch jobs and work abroad. Although Japan is popular among IT engineers in Southeast Asian countries such as Indonesia, it is less popular than Germany among IT engineers in China, the United States and India (Figure II-1-2-27).
Figure II-1-2-27  Countries in which IT engineers wish to work

<table>
<thead>
<tr>
<th></th>
<th>IT engineers’ country of residence</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>18.9% 79.7%</td>
</tr>
<tr>
<td>China</td>
<td>24.5% 73.1%</td>
</tr>
<tr>
<td>United States</td>
<td>26.8% 58.4%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>22.1% 50.5%</td>
</tr>
</tbody>
</table>

Note: Country names indicate the countries in which IT engineers wish to work.
Source: "International Comparative Research on IT Workers" (METI)

(C) Trend of Japanese companies expanding into Silicon Valley in pursuit of human resources and technology and challenges

While the evolution and penetration of new technologies such as IoT, artificial intelligence and robotics have had an increasingly large impact on existing industries, in many cases, companies within these industries face difficulty adapting to new technologies only by using internal institutional capabilities and assets that they already possess. Therefore, in order to acquire technologies they seek and human resources capable of creating such technologies, existing companies ahead of others in innovation are devoting efforts to incorporating external technologies through alliances with and acquisitions of external companies or to expanding into regions where such technologies and human resources are concentrated.

In particular, the abovementioned advanced technologies are concentrated in a handful of regions, including Silicon Valley, which has a cluster of globally competitive IT companies, so companies are actively moving into those regions.

In the automobile industry, a typical existing industry, companies are also relocating their business bases against the backdrop of the growing needs for new technologies essential for realizing connected cars and autonomous driving. As a result, the automobile industry’s cluster of research and development functions is shifting from Detroit, the industry’s major cluster in the United States, to Silicon Valley, with many companies attracted there from around the world (Figure II-1-2-28).
Against this background, an increasing number of Japanese companies are expanding into Silicon Valley. According to a survey conducted jointly by the Japanese Chamber of Commerce of Northern California and JETRO San Francisco, the number of Japanese companies expanding into the U.S. Bay Area, which includes Silicon Valley and San Francisco, in 2014 was the largest since JETRO started the survey (Figure II-1-2-29).

28 “Survey of Japanese Companies in the Bay Area,” which was jointly prepared by the Japanese Chamber of Commerce of Northern California and JETRO San Francisco. This survey was conducted on (i) local affiliates in which Japanese companies have made investments equivalent to 10% or more of the capital (including indirect investments), (ii) branch offices and representative offices of companies headquartered in Japan and (iii) companies founded and operated by Japanese nationals. The Bay Area includes 10 counties: San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, Marin, Napa, Sonoma, Solano and Sacramento.

Approaches for technological catchup intended to create new innovations can be broadly divided into three categories: incorporating technologies and human resources through alliances with or acquisitions of foreign companies; acquiring human resources through recruitment of foreign workers; and developing human resources by dispatching employees abroad (Figure II-1-2-30).
Meanwhile, according to an interview survey conducted on commission from the Ministry of Economy, Trade and Industry, on companies which have expanded into Silicon Valley from Japan and other countries, and companies, universities and research institutions in the region, Japanese companies are facing various challenges as they try to incorporate technologies and human resources from Silicon Valley and other advanced technology clusters abroad.

First, there is a “barrier of recognition.” In other words, Japanese companies expanding abroad face difficulty recruiting competent local workers because they are not well known there. In particular, for Japanese companies aiming to acquire or forming alliances with local companies, such lack of recognition may hamper progress in negotiations.

Even in the case of companies which are well known, there is a “barrier of interest.” In other words, such companies may be unable to attract interest because they fail to adequately demonstrate their records of achievements and which research and development themes they are pursuing under what kind of system, for example. In some cases, competent local engineers place priority on what they can do with whom after joining a new employer.

Japanese companies expanding abroad also face a “barrier of action.” For example, in some cases, they may fail to make progress in negotiations about an acquisition due to a lack of delegation of the decision-making authority to their local subsidiary. In other cases, they may have to give up on employing local workers because sufficient remuneration cannot be offered (Figure II-1-2-31).

Source: “Survey on the Influence of the Rise of Innovative Industries on Trade and Investment Patterns around the World” (a survey commissioned by METI) (Accenture)

29 Accenture (2016).
Issues faced by Japanese companies when incorporating foreign technologies
(Based on interviews in Silicon Valley)

Source: “Survey on the Influence of the Rise of Innovative Industries on Trade and Investment Patterns around the World” (a survey commissioned by METI) (Accenture)

In order to resolve such challenges and achieve technological catchup smoothly and promptly, Japanese companies are starting to engage in various initiatives. For example, in order to realize alliances with and acquisitions of foreign companies possessing advanced technologies, or to employ competent workers, some Japanese companies are assigning persons with successful records of achievement in a relevant field to management posts at local offices, thereby creating a governance system that enables quick decision-making at the local level. In such cases, what is important is that the senior management and operational staff at the headquarters support local decision-making and use information provided from local offices.

In addition, it is necessary to develop human resources internally while incorporating external technologies. It is considered to be important to create the background for employees in Japan to utilize foreign business methods and technologies by dispatching them to foreign offices or giving them simulated experiences through online platforms (Figures II-1-2-32 and II-1-2-33).

Key points in forming alliances with or acquiring foreign companies and employing local workers
(Created based on interviews in Silicon Valley)
In light of the results of the questionnaire survey described in (B), while Japan is facing a labor shortage, it is presumed that many IT-skilled workers in Japan are resigned to be content with the current situation in which they are receiving unfavorable treatment in terms of factors that they consider to be important, such as sense of job satisfaction, salary, position and skill improvement, and in which their job itself is not attractive. Presumably, such an unattractive working environment is not only hampering the attraction of new workers but also encouraging some engineers seeking a sense of satisfaction from their job to go abroad to find a new job, and this situation is creating a shortage of workers with IT integration skills, who are capable of creating new businesses and services, and is impeding the creation of competitive products and services.

In particular, it is said that when competent IT-skilled workers consider their career plans, they tend to place priority on improving their own skills in addition to the salary level. As a result, human resources tend to be concentrated at companies which have a well-developed environment for holding and using a large volume of data and at companies which have already attracted a large number of competent engineers, resulting in the acceleration of concentration of competent engineers from countries around the world at competitive IT companies, mainly in the United States.

In contrast, if Japan is to secure IT engineers, namely human resources for whom demand is growing around the world, there are presumably many challenges to be overcome in terms of salary, position, evaluation criteria and investment in human resource development, among other factors. This suggests that in order to secure human resources capable of creating innovations through new technologies, there is a growing need to quickly develop a diverse environment that enables companies and workers to make
successful achievements in consideration of initiatives conducted by Japanese companies which are ahead in innovation.

2. Innovation and employment of highly-skilled professionals

(1) Productivity trend by industry

As shown in Part I, Japan has until now been recording lower growth in total factor productivity (TFP) than the United States and Germany. On the other hand, it is true that the growth in TFP varies significantly from industry to industry.

Figures II-1-2-34 and II-1-2-35 show the growth in TFP by industry in the three countries.

**Figure II-1-2-34 Changes in TFP (by industry) (1)**

In Japan, TFP is low in manufacturing, agriculture, forestry and fisheries, transportation and warehousing, and wholesale and retail trade.
Agriculture, forestry and fisheries

Transportation and warehousing

Source: EUKLEMS
Figure II-1-2-35  Changes in TFP (by industry) (2)

Wholesale and retail trade

(1991=100)

Restaurants and accommodations

(1991=100)
IT and information services

- United States
- Germany
- Japan

Professional, science and technology services

- United States
- Germany
- Japan
From these figures, we can see that the growth in TFP is much lower in Japan than in the United States and Germany in such industries as manufacturing, agriculture, forestry and fisheries, transportation and warehousing, and wholesale and retail trade. In Japan, TFP in the manufacturing industry has continued to grow since the second half of the 1990s, but the pace of growth is much slower than in the United States and Germany. TFP growth has remained almost flat since the second half of the 1990s in Japanese industries such as agriculture, forestry and fisheries, transportation and warehousing, and wholesale and retail trade. On the other hand, the TFP growth in Japanese professional, science and technology services is higher than the growth in their U.S. and German equivalents.
Looking at the dispersion of the TFP growth rates among industries, what measures is it desirable for Japanese industrial society to take in order to drive Japan’s economic growth?

In Japan, where the aging of society coupled with a low birth rate is proceeding at a rapid pace, a dramatic expansion of the domestic goods and services markets is unlikely in the future. In this environment, industries with a high level of TFP, for example, can make significant contributions to Japan’s economic growth by seeking to increase production and employment through the expansion of goods and services exports using their high competitiveness. On the other hand, industries with a low level of TFP must raise their TFP by realizing technological innovation (Figure II-1-2-36).

**Figure II-1-2-36**  
*Industries with a high productivity should expand their scale, while those with a low productivity should raise their productivity*

Theoretically, it is desirable to convert all industries into innovative industries.

Although it is presumed to be relatively easy for the first group of industries, namely industries with high productivity, to realize the expansion of the market, the second group, namely industries with low productivity, will face difficulty raising their TFP.

If companies are to raise their TFP, innovation is essential. If companies acquire the ability to introduce new products and services by realizing innovation, they may be able to capture new markets. If substantial production cost reduction is realized through innovation of production technology, the competitiveness of products and services is certain to increase dramatically.

(2) **Conditions necessary for spreading the effects of TFP growth across national borders**

What conditions are necessary for spreading the effects of TFP growth across national borders?

Generally speaking, innovation refers to the process of creating new value by adding new knowledge to existing knowledge.

Existing knowledge, which represents the achievement of past innovations, includes public
knowledge and knowledge to which rights as intellectual property are granted. Public knowledge can be used for free via the Internet or other media, but if companies are to use intellectual property owned by other companies for their research and development or production activity, they need to purchase the right to use the property (receive technology licensing).

Moreover, in order to absorb the knowledge thus obtained and create new value by adding new knowledge to it, the presence of competent engineers is essential.

In recent years, it has become commonplace to receive technology licensing or to secure engineers across national borders.

Therefore, below, we will examine the relationship between cross-border knowledge diffusion and innovation. Then, we will show that the more active companies are in incorporating external knowledge and in accepting foreign engineers, the more successful they are in realizing innovation.

First, we will explain the channels of knowledge diffusion. Table II-1-2-37 shows specific examples of each channel of knowledge diffusion and the media of diffusion.

**Figure II-1-2-37  Channels of knowledge diffusion across national borders**

Japan should aim at technology trade and the acceptance of foreign engineers.

<table>
<thead>
<tr>
<th>Channel of diffusion</th>
<th>Example of diffusion methods</th>
<th>Media of diffusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade</td>
<td>Reverse engineering</td>
<td>Goods</td>
</tr>
<tr>
<td></td>
<td>Technology trade (technology licensing)</td>
<td>Services</td>
</tr>
<tr>
<td>Direct investment</td>
<td>Lending of equipment and technology (technology lending)</td>
<td>Goods and services</td>
</tr>
<tr>
<td></td>
<td>Acceptance of foreign engineers (technology spillover)</td>
<td>People</td>
</tr>
</tbody>
</table>

In the case of innovation creation by companies, mainly two channels of diffusion, trade and direct investment, are expected to be used. Regarding trade, there are two specific methods of diffusion: reverse engineering, which refers to acquiring manufacturing technology by disassembling imported foreign products, and technology licensing, which refers to making monetary payment to purchase the right to use foreign technology. Of these two, the latter is usually chosen by developed countries like Japan. These are examples of channels of international diffusion of knowledge via trade in goods and services.

In addition, knowledge is disseminated through direct investment. In this case, there are two specific methods of diffusion: lending of equipment and technology (technology lending) and acceptance of foreign engineers (technology spillover). Technology lending is a method whereby the investing country

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30 Actually, it is assumed that there are other channels, such as development assistance, research exchange between universities, and return of immigrants, but they are not discussed here.
provides goods or services, such as production equipment and operational methods, to the investment recipient country for the purpose of production. In this case, the producer in the investment recipient country is positioned merely as an operator of production equipment, so various pieces of knowledge embodied by production equipment and operational methods are not diffused.

On the other hand, if the recipient country receives not only production equipment and operational methods but also foreign engineers when accepting foreign investment, various pieces of knowledge are expected to be diffused. For example, this will make it possible to obtain, through face-to-face communication between engineers, knowledge (tacit knowledge) that would not be obtained in the form of explicit knowledge (public knowledge and technology licensing). In particular, when companies in developed countries like Japan receive foreign investment, making sure to incorporate the benefits of foreign innovation through the employment of foreign engineers will be important for raising the companies’ own TFP.

(A) Trade in technology and innovation

Figure II-1-2-38 shows changes in the ratio of charges for the use of patents, etc. (receipts and payments) to GDP in OECD countries. From this, we can see that since the 1990s, the size of global trade in technology has expanded rapidly. Against the backdrop of rapid economic globalization, cross-border trade in knowledge (knowledge diffusion) has become active around the world.

Figure II-1-2-38  Changes in global technology trade

Global technology trade has rapidly expanded since the 1990s.

Note: Weighted average of the ratio of charges for the use of patents, etc. (receipts and payments) to nominal GDP in OECD member states. Based on IMF Balance of Payments Manual (sixth edition). Gaps are corrected with the average of the changes in the ratio from the previous year over the recent three years.
Source: “World Economic Outlook Database, Oct 2015” (IMF)
The rapid rise in the ratio of charges for the use of patents, etc. to GDP also indicates that the importance of foreign knowledge for each country’s economic activities is growing.

Next, we will look at the current status of trade in technology by Japanese manufacturing industries. Figure II-1-2-39 shows trade in technology divided into two categories - trade in technology between parent companies and subsidiaries (internal trade in technology) and trade in technology between companies with no parent-subsidiary relationship (external trade in technology) - with respect to 19 manufacturing industries as classified by the Report on the Survey of Research and Development prepared by the Ministry of Internal Affairs and Communications.

**Figure II-1-2-39  Current status of technology trade in Japan’s manufacturing industries (1)**

Regarding internal technology trade, there is an excess of exports over imports. As for external technology trade, imports correlate highly with exports.
Note: The ratio of technology imports to sales and the ratio of technology exports to sales are averages over the period from 2002 to 2014.
Source: “Report on the Survey of Research and Development” (Ministry of Internal Affairs and Communications)

Regarding internal trade in technology, all of the 19 industries are located below the 45-degree line, indicating that there is an excess of exports over imports in these industries. This is due to the fact that most multinationals operating in Japan are Japanese multinationals as the amount of inward direct investments in Japan is very small. In other words, it is presumed that behind the excess of technology exports is the fact that the purpose of overseas expansion by Japanese companies is establishing overseas production bases in most cases, resulting in active transfer of production technologies from parent companies in Japan to overseas subsidiaries used as production bases.

As for external trade in technology, most of the 19 industries are located around the 45-degree line, indicating the presence of active external trade in technology.

Specifically in which industries is external trade in technology actively conducted? Figure II-1-2-40 shows changes in external trade in technology (the ratio to sales) in two periods, between 2002 and 2006 and between 2007 and 2012, with respect to the 19 manufacturing industries.

**Figure II-1-2-40  Current status of technology trade in Japan’s manufacturing industries (2)**
Internal technology trade is active in advanced technology industries, including pharmaceuticals and information and communication.

![Diagram showing external technology trade](image-url)

Source: “Report on the Survey of Research and Development” (Ministry of Internal Affairs and Communications)
From this figure, we can see that external trade in technology expressed as the ratio to sales is at a high level in Japanese representative advanced technology industries, including the manufacturing of pharmaceuticals, information and communications equipment, and electronic components, devices and circuits. The ratio to sales is outstandingly high for the manufacturing of pharmaceuticals, an industry in which research and development is particularly active.

In addition, a look at the TFP growth rates of all advanced technology industries (Figure II-1-2-41) shows that their growth rates are relatively high compared with the growth rates for other industries.

**Figure II-1-2-41**  TFP of the Japanese manufacturing industries

The TFP growth rates of advanced technology industries are relatively high.

TFP growth rate

(Annual average, %)

Source: “JIP Database 2014” (RIETI)

Figure II-1-2-42 shows the relationship between external trade in technology and TFP with respect to the 19 manufacturing industries as classified by the Report on the Survey of Research and Development prepared by the Ministry of Internal Affairs and Communications.
Figure II-1-2-42  External technology trade is closely related to TFP

(1) External technology imports and TFP growth rates

**External technology imports**

(TFP growth rate, %)

- Electronic parts, devices and electronic circuits
- Electrical machinery
- Transportation equipment
- General-use machinery
- Pharmaceuticals
- Nonferrous metals
- Chemicals
- Iron and steel

\[ y = 16.056x - 1.4678 \]

\[ R^2 = 0.4211 \]

(Ratio of the value of external technology imports to sales, %)

(2) External technology exports and TFP growth rates

**External technology exports**

(TFP growth rate, %)

- Information and communication electronics equipment
- Electronic parts, devices and electronic circuits
- Electrical machinery
- Transportation equipment
- General-use machinery
- Pharmaceuticals
- Chemicals
- Iron and steel

\[ y = 3.6986x + 0.8869 \]

\[ R^2 = 0.1193 \]

(Ratio of the value of external technology exports to sales, %)
External technology exports (excluding pharmaceuticals)

![Graph showing the relationship between the ratio of the value of external technology exports to sales and TFP growth rate.](image)

Source: “Report on the Survey of Research and Development” (Ministry of Internal Affairs and Communications) and “JIP Database 2014” (RIETI)

Regarding the relationship between the ratio of the value of external imports in technology to sales and the TFP growth rate, this figure indicates that there is a close correlation between these two. Industries with higher TFP growth rates and higher competitiveness are more active in incorporating technologies from external companies.

On the other hand, regarding the relationship between the ratio of the value of external exports in technology to sales, there is a strong positive correlation except in the case of the manufacturing of pharmaceuticals, for which the value of external technology exports is outstandingly high, indicating that industries with higher TFP growth rates and higher competitiveness are more active in providing technologies to external companies, just as such industries are active in incorporating technologies from external companies.

**(B) International movement of engineers and innovation**

Next, we will look at the relationship between the international movement of engineers and innovation.

Regarding the relationship between the cross-border movement of engineers and innovation, many empirical studies have been conducted, mainly in the United States.

Those studies are based on the assumption that receiving foreign engineers has the effect of promoting innovation in the receiving country by deepening communication between engineers and making it possible to obtain tacit knowledge that would not be obtained through the adoption of publicly
available technologies or technology imports and to absorb knowledge more firmly.

In the studies, the number of patent applications is often used as an indicator of the progress in innovation. Data concerning patent applications are easily available.

On the other hand, it is difficult to obtain data concerning the movement of engineers even in developed countries, including Japan. The United States is the only country where detailed information concerning cross-border movement of engineers is available, including the timing of departure, the destination country, the purpose of departure and the place of departure within the United States.

Hovhannisyan et al (2012) used the number of patent applications filed in the United States by 34 countries as the explained variable and departure data concerning U.S. engineers as the explanatory variable. The number of departures by U.S. engineers was weighted by the ratio of patent stocks to GDP in the state or county of departure. This method is supposed to make it possible to show, for example, that engineers from the state of California, where innovation activity is brisk, and engineers from the state of Nebraska, where innovation activity is sluggish, have different degrees of impact on innovation in the country they visit.

In addition, Hovhannisyan et al (2012) made their estimation by using several macro variables which are generally presumed to have an impact on innovation, such as research and development expenditures in the countries receiving engineers, in addition to data concerning the movement of engineers.31

The estimation results (Figure II-1-2-43) show that regardless of the presence or absence of other macro variables, the number of commercial travelers from the United States constantly maintains a statistically significant positive value. As expected, the results confirm that exchange with foreign engineers has positive effects on innovation in the receiving country.

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31 The macro variables are each receiving country’s population size, per-capita GDP, U.S. exports to and direct investments in the country, the country’s research and development expenditures, the number of patent applications filed in the country, and the country’s exports to and direct investments in the United States.
Table II-1-2-43  Estimation results concerning the international movement of human resources and innovation

If the number of US engineers visiting a country increases by 1%, innovation in the receiving country (number of patent applications in the United States) will increase by 0.022%.

<table>
<thead>
<tr>
<th>Dependant variable</th>
<th>Model (1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of commercial travelers from the US</td>
<td>0.022 *</td>
<td>0.022 *</td>
<td>0.022 *</td>
<td>0.021 *</td>
<td>0.022 *</td>
<td>0.022 *</td>
<td>0.028 *</td>
</tr>
<tr>
<td>Population</td>
<td>5.055 **</td>
<td>4.005 **</td>
<td>1.166</td>
<td>0.856</td>
<td>0.893</td>
<td>1.984 **</td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.750 *</td>
<td>0.602</td>
<td>0.226</td>
<td>0.184</td>
<td>0.245</td>
<td>1.139 **</td>
<td></td>
</tr>
<tr>
<td>Exports from the US</td>
<td>0.018</td>
<td>-0.119</td>
<td>-0.184</td>
<td>-0.159</td>
<td>-0.078</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct investment from the US</td>
<td>0.238 +</td>
<td>0.089</td>
<td>0.033</td>
<td>0.055</td>
<td>-0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D expenditures</td>
<td>1.131 **</td>
<td>0.835 **</td>
<td>0.831 **</td>
<td>0.552 **</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patent applications in the receiving country</td>
<td>0.534 **</td>
<td>0.502 **</td>
<td>0.484 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imports to the US</td>
<td>-0.093</td>
<td>-0.225</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct investment to the US</td>
<td>0.071</td>
<td>-0.106 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>5,202</td>
<td>5,202</td>
<td>5,202</td>
<td>5,202</td>
<td>5,202</td>
<td>5,202</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.1  *p<0.05 **p<0.01


(3) Summary

As shown above, for Japan, which is facing a population decline, it is essential to raise TFP through innovation, and importing foreign technologies and accepting foreign engineers are effective to a certain degree in raising TFP.

On the other hand, Japan is at a very low level in receiving foreign engineers. Figure II-1-2-44, which provides a comparison between Japan, the United States and China with respect to the number of short-stay commercial visitors, shows that the number of short-stay visitors to Japan has remained very low. The number of short-stay visitors to the United States is six times as high as the number of visitors to Japan, and the number of short-stay visitors to China is nearly five times as large although it has recently been on a downtrend.
Figure II-1-2-44  Changes in the number of short-stay commercial visitors to Japan, the United States and China

The number of short-stay visitors to Japan has remained low for a long time.


Data concerning the share of highly skilled immigrant workers with academic achievement equivalent to university degrees or higher in the overall number of immigrants in individual OECD countries shows that the share in Japan is very small, 1.5%, far below the 41% in the United States (Figure II-1-2-45). The data shows that highly-skilled professionals are heavily concentrated in the United States.
The number of highly skilled immigrant workers is extremely low for Japan.

Note: Murakami (2015).
"Highly skilled workers" refers to those with academic achievement equivalent to university degrees (ISCED 5-6).
Source: OECD stat.

It is argued that Japan is at a low level in receiving highly-skilled foreign professionals, whether short-stay visitors or immigrants, because even highly-skilled professionals are required to have Japanese language proficiency and adapt to traditional Japanese business practices, for example. In the future, Japan must make active efforts to resolve such problems and increase the number of highly-skilled professionals received from abroad and encourage them to stay in Japan for the long term.

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32 Refer to the Japan Institute for Labor Policy and Training (2013) p. 141, for example.