RIETI Discussion Paper Series 06-E-006

# International Intrafirm Transfer of Management Technology by Japanese Multinational Corporations

**URATA Shujiro**
RIETI

**MATSUURA Toshiyuki**
RIETI

**Yuhong WEI**
RIETI

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 06-E-006

# International Intrafirm Transfer of Management Technology by Japanese Multinational Corporations

Shujiro Urata
Waseda University and Research Institute of Economy, Trade and Industry
Toshiyuki Matsuura
*Research Institute of Economy, Trade and Industry*
Yuhong Wei
*Hitotsubashi University and Research Institute of Economy, Trade and Industry*

February 2006

## Abstract

Authors analyze the pattern of intrafirm transfer of management technology from Japanese multinational corporations (MNCs) to their overseas affiliates by using firm-level micro data and discern the determinants of the extent of technology transfer achieved. Defining intrafirm transfer of technology achieved as the case where responsibility of the task such as top management, sales, and labor management is given to local staff rather than Japanese staff, authors found that top management has been transferred at a limited number of affiliates, while the task of labor management has been transferred at many affiliates. Among the affiliates in different regions, technology transfer has been relatively more extensively achieved at affiliates in Europe, while it has been relatively limited at affiliates in ASEAN countries. An examination of the determinants of technology transfer revealed that the length of operation of the affiliates, and the quality of labor in the host countries have significantly positive impacts for the affiliates in Asia. These observations indicate the importance of providing an FDI friendly environment, under which MNCs are likely to stay for a long period, and the importance of improving the quality of human resources through education and training, in order to promote intrafirm transfer of management technology.

The authors thank helpful comments and discussions from the participants on the Workshop on Multinational Corporations: Their Behavior and Economic Impacts at RIETI, December 10, 2005 and seminar at RIETI, January 24, 2006. The authors are particularly indebted to Drs. Eric Ramstetter and Rene Belderbos and Mr. Yuji Hosoya for their very helpful comments.

## I. Introduction

Technological progress plays an important role in promoting economic growth, as it enables an economy to expand even if the factors of production such as labor and capital remain at the same level. Indeed, technological progress is considered necessary to maintain and accelerate economic growth, as the increase in the factors of production is likely to terminate sooner or later. For developing countries, absorption and assimilation of foreign technology, or international technology transfer, is an important method of achieving technological progress, because their capability in developing their own technology is limited.

Technology is a rather broad concept, ranging from production techniques to management know-how. As will be shown below in the literature review, many previous studies on international technology transfer focused on the technology related to production. Despite its importance on improvement of productivity of a firm, management know-how has not been studied much in the context of achieving economic growth and technology transfer in the past, partly because of the difficulty in quantifying management know-how.

International technology transfer takes various modes including purchasing technology from foreign countries in various forms including licensing, importing published materials, inviting foreign experts, foreign direct investment (FDI), and others. Among these modes of international technology transfer, FDI has become a major mode of international technology transfer in recent decades. Several reasons may be found for such developments. One is rapid expansion of FDI in the world, which in turn has been due to liberalization in FDI policies and the substantial reduction in the costs of international communication. These two factors contributed to rapid expansion of FDI

as they reduced the costs of undertaking FDI. Another reason that FDI has become a major mode of international technology transfer has to do with the strategy of multinational corporations (MNCs). Recognizing the importance of keeping technology inside MNCs to maintain their competitiveness, MNCs have been rather reluctant in selling their technologies to other firms in the form of licensing.

Two types of technology transfer involving MNCs can be identified. One is technology transfer from parent firms of MNCs to their overseas affiliates, and the other is technology transfer from overseas affiliates of MNCs to local firms. The former type of technology transfer is characterized as intrafirm technology transfer, the latter as technology spillover[1]. Intrafirm technology transfer has to take place before technology spillover is realized.

Intrafirm technology transfer is carried out by various means, including work experience (on the job training), and training programs to local employees. Technology spillover may be realized in different forms. Technology may be transferred from foreign firms to local firms, when local workers who have acquired knowledge from working at foreign firms move to local firms or start new business. Local firms may acquire technology from foreign firms by learning production and management technology or know-how from their business engagement with foreign firms through procurement of parts and components or sales of products, and by imitating production methods and management know-how practiced by foreign firms.

The objective of this paper is to analyze the extent of international intrafirm transfer of management technology achieved by Japanese manufacturing MNCs and to

[1] More precisely, technology spillover is defined as technology transfer, which is undertaken without market transactions. See Saggi (1999) for a survey of the literature on technology spillover and Javorcik and Spatareanu (2005) for a difficulty investigating the presence or absence of technology spillover.

identify the determining factors that could explain the extent of technology transfer. Our choice of Japanese MNCs was dictated by the availability of the data. We examine the extent of technology transfer for eight different job classifications, chief executive officer (CEO), deputy chief executive officer, chief of the sections including labor management, accounting, procurement, sales, research and development (R&D), and corporate planning.

An analysis of international intrafirm transfer of management technology would prove important not only for the host countries of FDI but also for MNCs. Host countries are concerned about the outcome of intrafirm technology transfer because successful technology transfer improves the technological capability of local workers, thereby contributing to economic growth. Indeed, host governments as well as employees working at the affiliates of foreign firms have often expressed dissatisfaction with the slow pace of technology transfer by MNCs. MNCs pay a lot of attention to intrafirm technology transfer because the performance of overseas affiliates of MNCs depends crucially on the success of intrafirm technology transfer, which would lead to efficient production and management.

The structure of the remainder of the paper is as follows. Section II presents a brief review of previous studies on international intrafirm technology transfer, in order to set the stage for our analysis. Although most past studies examined international intrafirm transfer of technologies related to production or research and development (R&D), and not management know-how, a review of past studies should prove useful for deepening our understanding of the issue. Section III examines the extent of international intrafrim transfer of management technology achieved at overseas affiliates of Japanese MNCs. Section IV has two subsections; one presents the

hypotheses to explain the extent of technology transfer achieved and the other analyzes the results of the regression analysis of the determinants of the extent of technology transfer. Section V concludes the paper.

## II. A Brief Review of the Studies on Intrafirm Technology Transfer

Several studies have examined the patterns of intrafirm technology transfer from parent firms to their overseas affiliates. Most of these studies examined the resources or the costs expended for intrafirm technology transfer by utilizing information obtained from case studies. Davies (1977) studied 119 cases of technology transfer by British companies in India. He found that British companies expend more resources for technology transfer, in the form of providing such tangibles as designs and components, as well as sending personnel, to their joint ventures with Indian firms than to local Indian firms.

Based on the information about the resource costs associated with twenty-six technology transfer projects undertaken by U.S. firms in chemicals and petroleum refining and machinery, Teece (1977) found that the costs of technology transfer were higher when technology recipients were joint ventures than when they were wholly owned foreign subsidiaries. He also found that the costs were higher when technology suppliers were less experienced in technology transfer and when recipients were less experienced in manufacturing.

Ramachandran (1993) found a similar relation between equity ownership and the resources used for technology transfer in his study of the characteristics of technology transfer agreements signed by Indian firms and MNCs from the United States, United Kingdom, and Western Europe. Analyzing the data aggregated into

fourteen industries, he found that MNCs spent more resources, in the form of sending engineers and training local employees in the MNCs' home countries, for technology transfer involving wholly owned subsidiaries than in the case of joint ventures, while they spent the least resources in the case of technology transfer to independent firms. In addition, R&D by licensees was found to reduce the amount of resources spent for technology transfer, indicating that high technological capability of the technology recipient facilitates technology transfer.

Wakasugi (1996) adopted a similar approach to study the costs of technology transfer by Japanese firms. Using information on resources expended for intrafirm technology transfer for 104 firms, Wasasugi performed statistical analyses to discern the determinants of the costs and lengths of the time required for transferring technology. Similar to the findings of other studies, he found that the greater the equity participation by the parent firm, the more resources spent for technology transfer. Past experience in technology transfer was found to lower the costs of technology transfer. The level of technology to be transferred was found to affect the costs of technology transfer, in that transferring high technology tends to cost more.

A very important issue regarding intrafirm technology transfer is to identify the circumstances and environments in which technology can effectively be transferred, but the previous studies discussed above did not address this issue directly. They instead examined the costs or resources involved in technology transfer, although costs or resources spent for technology transfer do not indicate the extent of technology transfer achieved. An increase in resources expended for technology transfer does not realize technology transfer if the resources are spent wastefully. To deal with this problem, several researchers adopted different approaches to measure the extent of technology

transfer achieved.

Yamashita (1991) measured the extent of technology transfer achieved by obtaining the information on the evaluation by personnel involved in technology transfer. He asked the personnel about his or her view on the level of technology transfer achieved. Specifically, he asked to what extent, such as 50 percent or 80 percent, the expectation of technology transfer has been achieved. He found that for many affiliates simple technology such as maintenance or repair of production line has been transferred but sophisticated technologies such as developing new products have not been transferred. One problem of this approach is the subjectivity of the evaluation. A manager in charge of technology transfer is likely to give high evaluation, while a personnel actually engaged in production may give a low evaluation.

Urata (1999) adopted a different approach. He evaluated the extent of technology transfer achieved by assessing who, either staff from the parent firm or local staff, has responsibility for managing technologies or assignments. Technology transfer is deemed to have been achieved if local staff is in charge of managing technologies. Using the sample of 133 cases of intrafirm technology transfer by Japanese MNCs to their Asian affiliates, he found a positive correlation between the extent of technology transfer and the degree of equity holding by the parent company only in the case where the technologies involved are simple, such as those related to the maintenance of machines. The opposite relation was found when the technologies involved were sophisticated, such as design technologies. His interpretation was that Japanese MNCs are reluctant to transfer technologies to their foreign affiliates, and they transfer these technologies under pressure from local joint venture partners. Urata also found that technology transfer is successfully carried out when Japanese MNCs adopt measures

specifically intended to promote technology transfer, such as providing manuals in the local language and holding seminars in local areas.

Several studies have examined the issue of staffing, either expatriate (from the parent company) or local staffing, at overseas affiliates of Japanese firms, an issue taken up by Urata, from business perspectives. Basically two lines of thoughts have been proposed to explain the expatriate staffing of the CEO of overseas affiliates. One emphasizes the importance of control of an affiliate by a parent company and coordination between a parent company and its affiliate, and the other places an importance on learning local business conditions. Based on these observations, Belderbos and Heijltjes (2005) investigated the determinants of expatriate staffing by Japanese electronics affiliates in Asia and found that both perspectives, that is, control-coordination and learning, were important determinants of expatriate staffing. Specifically, being consistent with the control-coordination line of thought, the probability of expatriate staffing is found high for the affiliates with low local sales orientation, high equity holdings by parent company, and large size. Supporting the learning hypothesis, experiences in local market is found to reduce the probability of expatriate staffing. In addition, they found that inter-firm linkages, or keiretsu network, also influenced expatriate staffing in that keiretsu affiliates can share information and experiences so that they do not have to rely much on expatriates.

## III. Intrafirm Transfer of Management Technology by Japanese Firms

We measure the extent of technology transfer achieved by identifying the nationality of personnel in charge of given tasks or positions. If local staff, rather than Japanese staff, is in charge, it is assumed that the technology has been transferred. This

methodology is admittedly very simplistic and possibly inaccurate, but in the absence of workable methodology largely because of a lack of necessary information, our methodology may be justified.

The METI survey asked Japanese MNCs whether local staff or Japanese staff was responsible for various job classifications at their overseas affiliates. We computed the proportion of the number of affiliates indicating that local staff is responsible in total number of firms for eight job classifications and the results are shown in Tables 1 and 2[2].

Wide variations can be found for the pattern of technology transfer achieved, or the localization of staff with responsibility, for different job classifications as well as for the affiliates in different regions. Technology transfer has been limited for the senior positions such as CEOs and deputy CEOs. In 2001 approximately 10-30 percent of the overseas affiliates had local personnel as CEO, while the proportions are somewhat higher around 30-50 percent for deputy CEOs. Among different job classifications, labor management registered high proportion of local staff at around 60-75 percent. This finding reflects the difficulty in managing local workers by Japanese staff because of the differences in social, cultural, and historic backgrounds and views between local and Japanese staff. The extent of technology transfer for other job categories is similar as approximately 40-60 percent of the affiliates had local staff responsible for the job.

Some regional differences can be identified for the pattern of technology

[2] The MITI survey collects information from overseas affiliates of Japanese firms, which are set up both in the forms of greenfield investment and mergers and acquisitions (M&As). We limited our sample to those set up through greenfield investments, because technology transfer patterns or staffing practices at the affiliates set up through M&As appears to differ substantially from those set up through greeenfield investment.

transfer. Technology transfer has been limited for the affiliates in ASEAN, while it has been most advanced for those in Europe. One may conjecture that the affiliates in ASEAN face difficulty in recruiting highly capable workers for the job.

Various factors are responsible for the determination of the extent of technology transfer achieved, as we will examine in later sections. However, at this point, we would like to see the relationship between the length of operation and technology transfer, because Japanese firms tend to develop the capabilities of local workers through on-the-job training, which is given more or less continuously and constantly for the extended time period. Table 2 shows the extent of technology transfer achieved by the length of operation. The figures in the table indicate that the extent of technology transfer increases with the length of operation for the affiliates in Asia, especially for those in ASEAN and China, while such pattern cannot be found for the affiliates in Europe or in North America. We will examine if such pattern can still persists by controlling the impacts of other factors by conducting statistical analysis later.

## IV. The Determinants of Intrafirm Transfer of Management Technology: The Hypotheses

We saw the extent of intrafirm international transfer of management technology (TT) achieved by Japanese firms to their overseas affiliates in the previous section. In this section we attempt to discern the determining factors for intrafirm transfer of management technology. In the analysis we divide the possible explanatory factors into three groups. One group of factors concerns the characteristics and strategies of the Japanese parent firms, and another concerns those of their overseas affiliates. The third

group of factors is related to the characteristics of the host countries of overseas affiliates of Japanese MNCs.

It should be noted here that because of our use of the nationality of the staff responsible for the task as the measurement of international technology transfer, not only technology transfer strategy but also staffing strategy of MNCs would have influences on the extent of technology transfer achieved. As such, we attempt to separate the effects of these two strategies as much as possible in our discussions below.

To begin with the characteristics of the parent firms, one would expect the firm size to affect the extent of technology transfer. Large firms are more able to transfer technology than small firms because large firms possess greater financial and human resources, which may be used for technology transfer. However, large firms with abundant human resources may not have much incentive to transfer technology because parent firms can provide technology to their affiliates whenever technical assistance is needed because of abundant human resources. In other words, large firms can retain control over their affiliates by limiting technology transfer, if they wanted. Furthermore, large firms with excess supply of workers in Japan, possibly because of declining business in Japan, may use the positions at their overseas affiliates for their Japanese staff from Japan. Based on these observations, the expected sign of the parent firm size (PSIZE), which is measured by the number of workers at parent companies, is ambiguous.

Previous experiences in transferring technology by parent firms should facilitate technology transfer. Indeed, several studies reviewed earlier have confirmed this effect (e.g., Teece 1977, Wakasugi 1996). Because appropriate information is lacking in the METI survey, we use the share of overseas sales in total sales (the sum of

sales in Japan and overseas sales) (POSALE) to capture the experiences in overseas activities. POSALE also reflects the extent of internationalization or openness of the parent firms. Considering these factors, we expect POSALE to have a positive impact on technology transfer.

Turning to the characteristics of overseas affiliates, which depend largely on the strategies of their parent firms, especially in the case of Japanese firms, one can think of several factors that could affect the extent of intrafirm transfer of management technology. The length of operation (AAGE) is likely to be an important factor, as was implied by an earlier observation in Table 2. The longer an affiliate has been operating, the greater the extent of technology transfer expected. Local staff at overseas affiliates accumulates experiences over time, which in turn facilitates technology transfer. Experiences have an important effect on intrafirm technology particularly for Japanese firms, since on-the-job training plays an important role in transferring technology for Japanese firms. Based on these discussions, we expect AAGE to have a positive impact.

The share of equity of an overseas affiliate held (AEQY) by its parent firm has been shown by previous studies to affect the pattern of intrafirm technology transfer, as was discussed in an earlier section. Several studies have shown that the cost of intrafirm technology transfer declines as the share of equity holding by the parent firm increases (see Teece 1977; Ramachandran 1993). The reason behind this relationship is that the threat of the misuse of technologies declines with the level of equity held by parent firms. However, one may expect different relationship between AEQY and the extent of technology transfer. A parent firm may not feel the need to transfer technology to majority-owned affiliates, because the affiliates can depend on their parent company for the supply of technology. There is yet another reason one may posit the negative

relationship between equity ownership and the level of transfer of management technology, especially when it is measured by the nationality of the personnel in charge of job assignment. Parent firms tend to assign Japanese staff to responsible positions in a majority owned affiliate because they try to control the management of the affiliate. Furthermore, parent firms assign staff from parent firms as a part of staffing strategy, who do not have relevant positions at the parent firms. Such assignment is not unusual for Japanese firms, which practice a life-time employment system. Based on these observations, the expected sign of AEQY is not clear.

Several additional control variables are included in the analysis. The attitude of parent firms and/or their affiliates concerning their relationship with local market in terms of sales and procurement is expected to have impacts on the nationality of personnel in charge of various assignments. One would expect the affiliates with close ties with local market to realize the need to have local staff in responsible positions or the need for technology transfer, in order to have good business relations with local businesses. Because of these reasons we expect the share of local procurement in total procurement of inputs (APROC) and the share of local sales in total sales (ASALE) to have positive relationships with technology transfer.

Finally, we include the size of affiliates (ASIZE) to consider the importance of affiliates' operation for parent companies, which is captured by the size in terms of the number of employees, in determining technology transfer. ASIZE is included in the estimated equation mainly as a control variable, because the impact of ASIZE on the nationality of staff is more related to staffing strategy than technology transfer strategy. One may conjecture that ASIZE to have a negative impact on technology transfer as parent firms may control the operation of important affiliates by assigning Japanese

staff to responsible positions. Alternatively, one may posit that the local staff is likely to take a responsible position for the affiliates with large number of workers because local staff may be in a better position than Japanese staff to manage a large number of local workers. Furthermore, the chances of employing capable local workers are high for the affiliates with many workers, enabling these affiliates to assign local staff to responsible assignments.

As for the variables concerning the host countries, we include two types of variables. One is the level of industrialization (HMFG) and the other is the quality of labor force (HEDU). Both variables represent the capability of labor force to take important positions in the affiliates of Japanese firms. Accordingly, both HMFG, which is measured by the share of manufacturing value added in total value added, and HEDU, which is measured by the attainment ratio for the secondary education, are expected to have positive impacts on technology transfer.

## V. The Determinants of Intrafirm Technology Transfer: The Results

We conducted regression analyses to test the validity of the arguments presented above concerning the determinants of intrafirm transfer of management technology, which is evaluated by the nationality of the staff responsible for the job. If the local staff is in charge, then it is interpreted that technology transfer is achieved. The estimation was conducted for the information obtained from the surveys conducted by the Ministry of Economy, Trade and Industry, Kaigai Jigyo Katsudo Kihon Chosa [Comprehensive Survey of Overseas Activities of Japanese Firms] and Kigyo Katsudo Kihon Chosa [Basic Survey of Business Structure and Activity]. Utilizing the panel dataset constructed from the surveys for 1995, 1998, and 2001, we applied the Random

Effect Probit Model, because the dependent variable takes either 0 or 1; 0 for the case where a staff in charge is Japanese, and 1 for the case where a staff is local.

The results of the regression analyses are shown in Table 3. The table includes three sets of results, A) for all the affiliate in the world, B) those in Asia, and C) those in developed countries (the US and the EU). We analyze the affiliates in Asia and in developed countries separately, because the determinants of transfer of management technology are likely to differ for these affiliates, which in turn are due to the differences in Japanese firms' strategies in these two groups of countries. Specifically, Japanese firms are interested in transferring their management technology to their affiliates in developing countries. By contrast, relatively speaking Japanese firms would be interested in utilizing local management technology at their affiliates in developed countries, since efficient management technology is likely to be available in developed countries. We will examine if such differences exist below.

The results indicate that the characteristics of parent firms, their overseas affiliates and the host countries have important impacts on international intrafirm transfer of management technology. To begin with the characteristics of parent firms, the results show that overseas experiences (POSALE) tend to facilitate transfer of management technology in the areas of sales, human resource management, and corporate planning at the affiliates in developed countries, while overseas experiences do not have any impacts on technology transfer at the affiliates in Asia.

Large size (PSIZE) is found to discourage transfer of technology for all types of management. As we discussed, large firms have abundant Japanese staff at home, so that they can assign Japanese staff to responsible positions at their overseas affiliates. Large firms tend to assign Japanese staff to important positions at overseas affiliates

under their well-developed human resource management system involving not only parent company but also their overseas affiliates. Indeed, many large firms use important positions at overseas affiliates as a proving position for Japanese staff's capability. These results appear to reflect staffing strategy rather than technology transfer strategy of the Japanese MNCs.

Turning to the results on the characteristics of the overseas affiliates, we find that the affiliates with strong local orientation, in terms of their procurement (APROC) and sales (ASALE), to have successfully transferred technology. Between the two, local orientation in terms of sales has a stronger impact on transfer of management technology. These findings are reasonable as one would expect the firms with strong local market orientation to promote local staff for responsible positions.

The size of overseas affiliates (ASIZE) is shown to have a positive impact on technology transfer. This finding appears to indicate the strategy of parent firms that assign local staff to responsible positions for the large affiliates. However, this tendency is found only for the affiliates in developed countries (Table 3C), and not for those in Asia (Table 3B). The contrasting patterns observed for the affiliates in developed countries and those in Asia may reflect the differences in the availability of capable human resources. Specifically, capable employees are available at large affiliates in developed countries, so that local employees are assigned to important positions, while capable employees are in short supply for the affiliates in Asia. Another reason for these contrasting findings for the affiliates in developed countries and those in Asia may be due to difficulty in managing large affiliates in terms of employment by Japanese staff at the affiliates in developed countries because of a variety of requests and demands presented by workers and because of a wide variety of business activities at large

affiliates. It is interesting to observe that for the affiliates in Asia the relationship is found positive only for the position in charge of labor management. This finding supports the arguments above in that despite a shortage of capable workers at the affiliates in Asia local staff is given responsibility in labor management at large affiliates because of the difficulty in labor management, which increases with the size of the affiliates. To put it differently, the difficulty in managing workers by Japanese staff arises at the affiliates in Asia as well as those in developed countries as the size of the affiliate increases.

The length of operation of the affiliates (AAGE) shows a significantly positive impact on transfer of management technology for the affiliates in Asia, but not for the affiliates in developed countries. Indeed, for the affiliates in developed countries AAGE is shown to have a negative impact with statistical significance for the positions of CEO, procurement and labor relations. The finding for the Asian affiliates is consistent with our expectation, and it indicates the importance of experiences for learning management know-how by local staff. The reasons for the finding for the affiliates in developed countries are not clear and thus detailed investigation is warranted. It may be possible that anomalous practices of a few affiliates with very long operation history in developed countries might have caused the result.

The pattern of equity ownership influences technology transfer. The estimated coefficients on AEQY show that a large equity share by Japanese firms discourages transfer of management technology regardless of the location of the affiliates. This observation may be explained by the strategy of Japanese parent firms that for important affiliates, reflected in high equity holding, parent firms assign Japanese staff in responsible positions. This finding is not consistent with the findings from the previous

studies on technology transfer, reviewed in an earlier section. One of the reasons for this inconsistency may be due to the differences in the measurement of technology transfer. Earlier studies examined the costs expended for technology transfer, while our study examined the achievement of technology transfer. These contrasting findings may indicate that technology transfer does not necessary depend on the resources spent for technology transfer.

Concerning the factors in the host countries, we found that the level of industrialization (HMFG) has a significantly positive impact on transfer of management technology for the affiliates in the world. This expected result indicates the importance of industrialization experience for assimilating management technology. Quality of labor force (HEDU) is found to have a significantly positive impact on technology transfer only for the affiliates in Asia, and not for the affiliates in developed countries. The finding on the affiliates in Asia is consistent with the finding by Ramachandran (1993), indicating the importance of technological capability of the technology recipient for successful technology transfer. The unexpected finding for the affiliates in developed countries may be attributable to small variations in HEDU for developed countries.

In order to examine the robustness of our earlier findings, we conducted a dynamic analysis of the determinants of transfer of management technology for the overseas affiliates of Japanese firms. Taking advantage of the panel dataset, we examined the characteristics of the affiliates that shifted job responsibility from Japanese to local employees. Specifically, we used the information on the affiliates where job responsibility was assigned to Japanese employees in period t (1995 or 1998). Given this dataset we identify affiliates, where job responsibility was shifted to local

employees in period t+1, and we assign unity for such affiliates. For the affiliates, where job responsibility remained in the hands of Japanese, we assign zero. This information, either unity or zero, is used as a dependent variable in our regression analysis. The Probit estimation was adopted and the results of the estimation for CEO, sales and procurement tasks are shown in Table 4. One notable finding from the results is the importance of the host country characteristics, namely the level of industrialization and the quality of labor force, for transfer of management technology, particularly for the affiliates in Asia, which is consistent with our earlier findings in Table 3.

## V. Conclusions

Our analysis of transfer of management technology at overseas affiliates of Japanese firms and their determinants revealed a number of interesting and important observations. As to technology transfer among different job classification, technology has not been transferred much for high-ranking and important positions such as CEOs and deputy CEOs, while technology has been transferred for the jobs requiring close local contact such as labor management.

The statistical analysis of the determinants of transfer of management technology found the importance of the characteristics and strategies of parent firms as well as their affiliates, in addition to the characteristics of the host countries, in determining the extent of technology transfer. Among them, particularly important findings from the perspective of policy makers include the followings. We found that technology transfer is undertaken for the overseas affiliates with close local ties in sales and purchase. The length of operation of the affiliates was found to be important for technology transfer for the affiliates in Asia. Furthermore, we found that technology is transferred for the affiliates

located in a host country with high level of industrialization. Availability of high quality of labor is found to promote technology transfer for the countries in Asia.

Several important policy implications can be obtained from our analysis for the countries eager to have management technology transferred. First, the countries have to provide an FDI friendly environment, under which overseas affiliates can operate for long period of time. This is because technology transfer takes time. Second, development of capable workers through education and training is very important, because without them technology transfer is impossible. Third, development of competitive manufacturing sector is important for technology transfer. With competitive local industry, overseas affiliates can increase interaction with local manufacturing firms, which in turn would facilitate not only intrafirm technology transfer, which was the subject of this paper, but also technology spillover to local firms. In order to deal with these policy challenges, the government of developing countries should formulate comprehensive development policies ranging from human resource development to FDI policies and implement them effectively.

Finally, we would like to end this paper by indicating the agenda for future research regarding technology transfer. First, the impacts of technology transfer should be examined. This paper examined the extent of technology transfer achieved but it did not analyze how technology transfer affected the performance of overseas affiliates. Without discerning the impacts of technology transfer on performance such as profitability and productivity, the analysis of technology transfer is not completed. Second, it would be important to conduct an international comparison among MNCs from different countries concerning the extent of technology transfer. Such study would reveal the differences and similarities of technology transfer among them. In this regard MITI (2000) reports that for the affiliates in Asia the proportion of expatriates (staff from the home country) in total

CEOs is high at 72 percent for Japanese firms while the corresponding figures for US and German firms are 26 and 23 percent, respectively. These observations are useful but detailed analysis is warranted. Finally, case studies of technology transfer, which would complement our statistical study, should be conducted, in order to deepen our understanding of technology transfer.

References

Beldeerbos, Rene A. and Marielle G. Heijltjes (2005) “The Determinants of Expatriate Staffing by Japanese Multinationals in Asia: Control, Learning, and Vertical Business Groups,” *Journal of International Business Studies*, 36 (3), pp.341-354.

Davies, Howard (1977) “Technology Transfer through Commercial Transactions, *Journal of Industrial Economics* 26 (December), pp. 161-75.

Javorcik, Beata Smarzynska and Mariana Spatareanu (2005) “Disentangling FDI Spillover Effects: What Do Firms Perceptions Tell Us?” in T.H.Moran, E.M.Graham and M Blomstrom eds. *Does Foreign Direct Investment Promote Development?* Institute for International Economics, Washington, D.C, pp. 45-71.

Ministry of International Trade and Industry (2000) *White Paper 2000* (in Japanese)

Ramachandran, Vijaya (1993) “Technology Transfer, Firm Ownership, and Investment in Human Capital,” *Review of Economics and Statistics* 75 (November), pp. 664-70.

Saggi, Kamal (1999) “Trade, Foreign Direct Investment, and International Technology Transfer: A Survey,” Policy Research Working Paper Series 2349, the World Bank.

Teece , David J. (1977) “Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-how, *Economic Journal* 87 (June), pp.

242-61.

Urata, Shujiro (1999) "Intrafirm Technology Transfer by Japanese Multinationals in Asia," in Dennis J. Encarnation ed.. *Japanese Multinationals in Asia: Regional Operations in Comparative Perspective*, Oxford University Press, New York, 1999

Wakasugi, Ryuhei (1996) “Gijutsu Iten no Kettei Yoin [The Determinants of Technology Transfer], in *Kagai Chokusetsu Toshi to Nihon Keizai [Foreign Direct Investment and the Japanese Economy]*, ed. Sueo Sekiguchi and Hiroshi Tanaka, Toyo Keizai Shimpo Sha, pp. 98-110.

Yamashita, Shoichi (1991)'Economic Development of the ASEAN Countries and the Role of Japanese Direct Investment,' in Sohichi Yamashita ed. *Transfer of Japanese Technology and Management to the ASEAN Countries*, University of Tokyo Press, pp.3-22

Table 1 Intrafirm Technology Transfer for Japanese Firms

| | Year of Survey | ASEAN | NIES | China | Europe | North America |
|---|---|---|---|---|---|---|
| CEO | 1995 | 0.259 | 0.280 | 0.351 | 0.194 | 0.199 |
| | 1998 | 0.196 | 0.213 | 0.265 | 0.242 | 0.167 |
| | 2001 | 0.143 | 0.186 | 0.193 | 0.289 | 0.190 |
| Deputy CEO | 1995 | 0.231 | 0.345 | 0.514 | 0.412 | 0.378 |
| | 1998 | 0.283 | 0.411 | 0.501 | 0.464 | 0.374 |
| | 2001 | 0.308 | 0.412 | 0.512 | 0.493 | 0.432 |
| Labor Management | 1995 | 0.724 | 0.567 | 0.813 | 0.634 | 0.603 |
| | 1998 | 0.695 | 0.606 | 0.734 | 0.700 | 0.691 |
| | 2001 | 0.696 | 0.579 | 0.716 | 0.730 | 0.648 |
| Accounting | 1995 | 0.627 | 0.582 | 0.645 | 0.527 | 0.508 |
| | 1998 | 0.558 | 0.593 | 0.589 | 0.580 | 0.568 |
| | 2001 | 0.548 | 0.558 | 0.610 | 0.610 | 0.551 |
| Sales | 1995 | 0.440 | 0.476 | 0.691 | 0.559 | 0.573 |
| | 1998 | 0.460 | 0.491 | 0.596 | 0.612 | 0.558 |
| | 2001 | 0.449 | 0.475 | 0.584 | 0.658 | 0.610 |
| Purchase | 1995 | 0.480 | 0.514 | 0.729 | 0.610 | 0.628 |
| | 1998 | 0.554 | 0.553 | 0.666 | 0.661 | 0.676 |
| | 2001 | 0.559 | 0.558 | 0.642 | 0.712 | 0.678 |
| R&D | 1995 | 0.486 | 0.660 | 0.643 | 0.683 | 0.541 |
| | 1998 | 0.459 | 0.565 | 0.531 | 0.631 | 0.553 |
| | 2001 | 0.395 | 0.673 | 0.436 | 0.663 | 0.520 |
| Planning | 1995 | 0.500 | 0.608 | 0.658 | 0.694 | 0.460 |
| | 1998 | 0.506 | 0.541 | 0.593 | 0.595 | 0.577 |
| | 2001 | 0.480 | 0.534 | 0.579 | 0.614 | 0.599 |

Note: The figures indicate the proportion of overseas affiliates of Japanese firms with local staff taking responsibility in total number of affiliates.
Source: METI, Kaigai Jigyokatsudo Kihon Chosa
[Comprehensive Survey of Overseas Activities of Japanese Firms], various issues

Table 2 Intrafirm Technology Transfer by the Length of Operation

| | | All industry | | | | |
|---|---|---|---|---|---|---|
| | Length of Operation | ASEAN | NIES | China | Europe | North America |
| CEO | 0-5 | 0.081 | 0.163 | 0.179 | 0.257 | 0.186 |
| | 6-10 | 0.143 | 0.139 | 0.191 | 0.243 | 0.224 |
| | 11-15 | 0.113 | 0.246 | 0.286 | 0.279 | 0.188 |
| | 16- | 0.263 | 0.184 | 0.167 | 0.326 | 0.181 |
| Deputy CEO | 0-5 | 0.256 | 0.448 | 0.460 | 0.367 | 0.378 |
| | 6-10 | 0.382 | 0.376 | 0.521 | 0.517 | 0.405 |
| | 11-15 | 0.254 | 0.430 | 0.600 | 0.505 | 0.407 |
| | 16- | 0.342 | 0.403 | 0.667 | 0.528 | 0.481 |
| Human Resource Management | 0-5 | 0.606 | 0.475 | 0.610 | 0.746 | 0.628 |
| | 6-10 | 0.719 | 0.506 | 0.734 | 0.683 | 0.548 |
| | 11-15 | 0.681 | 0.657 | 0.963 | 0.758 | 0.711 |
| | 16- | 0.783 | 0.616 | 0.833 | 0.725 | 0.646 |
| Accounting | 0-5 | 0.517 | 0.453 | 0.583 | 0.556 | 0.528 |
| | 6-10 | 0.584 | 0.531 | 0.605 | 0.667 | 0.587 |
| | 11-15 | 0.531 | 0.651 | 0.786 | 0.642 | 0.548 |
| | 16- | 0.554 | 0.552 | 0.667 | 0.589 | 0.551 |
| Sales | 0-5 | 0.403 | 0.543 | 0.522 | 0.684 | 0.557 |
| | 6-10 | 0.459 | 0.379 | 0.583 | 0.677 | 0.581 |
| | 11-15 | 0.421 | 0.490 | 0.870 | 0.740 | 0.580 |
| | 16- | 0.525 | 0.496 | 0.750 | 0.593 | 0.660 |
| Procurement | 0-5 | 0.489 | 0.527 | 0.605 | 0.733 | 0.684 |
| | 6-10 | 0.572 | 0.455 | 0.632 | 0.741 | 0.634 |
| | 11-15 | 0.564 | 0.594 | 0.889 | 0.755 | 0.725 |
| | 16- | 0.608 | 0.612 | 0.750 | 0.669 | 0.656 |
| R&D | 0-5 | 0.341 | 0.667 | 0.486 | 0.929 | 0.636 |
| | 6-10 | 0.273 | 0.500 | 0.402 | 0.765 | 0.441 |
| | 11-15 | 0.395 | 0.656 | 0.556 | 0.542 | 0.470 |
| | 16- | 0.583 | 0.771 | 0.667 | 0.581 | 0.552 |
| Planning | 0-5 | 0.436 | 0.577 | 0.489 | 0.594 | 0.488 |
| | 6-10 | 0.387 | 0.444 | 0.582 | 0.767 | 0.548 |
| | 11-15 | 0.527 | 0.465 | 0.857 | 0.509 | 0.627 |
| | 16- | 0.561 | 0.625 | 0.500 | 0.635 | 0.637 |

Note: The figures indicate the proportion of overseas affiliates of Japanese firms with local staff taking responsibility in total number of affiliates.
Source: METI, Kaigai Jigyokatsudo Kihon Chosa
[Comprehensive Survey of Overseas Activities of Japanese Firms], No. 32, 2004.

Table 3.A The Determinats of Transfer of Management Technology: Affiliates in the World

| Dep variable | CEO | Sales | Purchase | Labor | R&D | Plannnig |
|---|---|---|---|---|---|---|
| # of obs | 6502 | 5651 | 5560 | 5877 | 2062 | 2762 |
| # of groups | 4746 | 4226 | 4176 | 4347 | 1769 | 2318 |
| POSALE | 0.105 | 0.437 | 0.079 | 0.364 | -0.054 | 1.118 |
| | [0.57] | [2.54]** | [0.47] | [2.32]** | [-0.21] | [4.58]*** |
| PSIZE | -0.052 | -0.086 | -0.100 | -0.049 | -0.133 | -0.220 |
| | [-2.32]** | [-4.12]*** | [-5.00]*** | [-2.58]*** | [-4.46]*** | [-7.51]*** |
| APROC | 0.217 | | 0.162 | -0.094 | 0.093 | 0.051 |
| | [2.53]** | | [2.09]** | [-1.29] | [0.79] | [0.46] |
| ASALE | 0.413 | 0.462 | | 0.475 | 0.388 | 0.577 |
| | [4.75]*** | [5.82]*** | | [6.60]*** | [3.26]*** | [4.98]*** |
| AAGE | 0.003 | 0.001 | 0.003 | 0.002 | 0.017 | 0.009 |
| | [0.71] | [0.23] | [0.83] | [0.69] | [3.13]*** | [1.75]* |
| AEQY | -0.036 | -0.017 | -0.017 | -0.015 | -0.016 | -0.017 |
| | [-23.71]*** | [-11.66]*** | [-12.06]*** | [-11.22]*** | [-8.16]*** | [-8.70]*** |
| ASIZE | 0.032 | 0.061 | 0.066 | 0.181 | 0.038 | 0.171 |
| | [1.36] | [2.72]*** | [3.05]*** | [8.63]*** | [1.10] | [5.38]*** |
| HMFG | 0.015 | 0.018 | 0.013 | 0.016 | 0.001 | 0.001 |
| | [2.64]*** | [3.61]*** | [2.71]*** | [3.53]*** | [0.15] | [0.10] |
| HEDU | 0.035 | 0.024 | 0.022 | 0.013 | 0.029 | 0.019 |
| | [8.00]*** | [5.44]*** | [5.14]*** | [3.24]*** | [4.64]*** | [3.29]*** |
| C | -6.607 | 8.160 | 1.264 | 7.332 | 0.660 | -0.143 |
| | [-0.00] | [0.02] | [0.98] | [0.00] | [0.71] | [-0.15] |

Note: 1) '*','**', '***' indicate statistical significance at 10, 5, 1 percent, respectively.
2) Random-effect probit model is used for estimation.
3) Figures in brankets indicate z-ratio.
4) Industry dummies, year dummies and regional dummies are included.
Source: Authors' estimattion

Table 3.B The Determinats of Transfer of Management Technology: Affiliates in Asia

| Dep variable | CEO | Sales | Purchase | Labor | R&D | Plannnig |
|---|---|---|---|---|---|---|
| # of obs | 3746 | 3204 | 3261 | 3440 | 1219 | 1428 |
| # of groups | 2715 | 2391 | 2435 | 2518 | 1036 | 1233 |
| POSALE | -0.182 | 0.089 | -0.405 | -0.046 | -0.041 | 0.929 |
| | [-0.68] | [0.39] | [-1.83]* | [-0.22] | [-0.12] | [2.84]*** |
| PSIZE | -0.025 | -0.067 | -0.124 | -0.023 | -0.156 | -0.162 |
| | [-0.82] | [-2.50]** | [-4.86]*** | [-0.97] | [-3.97]*** | [-4.48]*** |
| APROC | 0.442 | | 0.308 | 0.059 | 0.196 | 0.262 |
| | [3.77]*** | | [3.11]*** | [0.63] | [1.24] | [1.83]* |
| ASALE | 0.246 | 0.157 | | 0.266 | 0.283 | 0.460 |
| | [2.04]** | [1.51] | | [2.85]*** | [1.75]* | [3.11]*** |
| AAGE | 0.011 | 0.008 | 0.013 | 0.015 | 0.031 | 0.015 |
| | [1.92]* | [1.49] | [2.56]** | [3.09]*** | [4.03]*** | [2.12]** |
| AEQY | -0.041 | -0.019 | -0.018 | -0.016 | -0.017 | -0.017 |
| | [-19.32]*** | [-10.56]*** | [-10.46]*** | [-9.53]*** | [-6.60]*** | [-7.04]*** |
| ASIZE | -0.090 | -0.063 | -0.066 | 0.046 | -0.084 | 0.033 |
| | [-2.56]** | [-2.06]** | [-2.28]** | [1.69]* | [-1.68]* | [0.76] |
| HMFG | 0.021 | 0.027 | 0.021 | 0.023 | 0.009 | 0.011 |
| | [3.14]*** | [4.74]*** | [3.76]*** | [4.47]*** | [1.03] | [1.48] |
| HEDU | 0.053 | 0.039 | 0.031 | 0.023 | 0.042 | 0.038 |
| | [9.36]*** | [6.92]*** | [5.85]*** | [4.57]*** | [5.42]*** | [5.29]*** |
| C | -6.733 | 7.942 | -7.610 | 7.170 | 0.980 | -0.341 |
| | [-0.00] | [0.01] | [-0.00] | [0.00] | [0.91] | [-0.34] |

Note: 1) '*','**', '***' indicate statistical significance at 10, 5, 1 percent, respectively.
2) Random-effect probit model is used for estimation.
3) Figures in brankets indicate z-ratio.
4) Industry dummies, year dummies and regional dummies are included.
Source: Authors' estimattion

Table 3.C The Determinats of Transfer of Management Technology: Affiliates in Developed Coun

| Dep variable | CEO | Sales | Purchase | Labor | R&D | Plannnig |
|---|---|---|---|---|---|---|
| # of obs | 2381 | 2109 | 1982 | 2101 | 743 | 1149 |
| # of groups | 1754 | 1582 | 1505 | 1580 | 645 | 940 |
| POSALE | 0.500 | 0.993 | 0.513 | 0.845 | -0.591 | 1.084 |
| | [1.21] | [3.55]*** | [1.87]* | [3.08]*** | [-1.21] | [2.49]** |
| PSIZE | -0.145 | -0.101 | -0.100 | -0.108 | -0.146 | -0.329 |
| | [-2.55]** | [-2.81]*** | [-2.84]*** | [-2.99]*** | [-2.40]** | [-5.02]*** |
| APROC | -0.027 | | -0.070 | -0.291 | -0.032 | -0.139 |
| | [-0.13] | | [-0.52] | [-2.14]** | [-0.14] | [-0.64] |
| ASALE | 0.371 | 0.628 | | 0.436 | 0.208 | 0.338 |
| | [1.82]* | [4.60]*** | | [3.20]*** | [0.89] | [1.54] |
| AAGE | -0.021 | -0.008 | -0.014 | -0.015 | -0.007 | -0.001 |
| | [-2.31]** | [-1.43] | [-2.37]** | [-2.70]*** | [-0.66] | [-0.13] |
| AEQY | -0.036 | -0.009 | -0.011 | -0.012 | -0.015 | -0.016 |
| | [-8.33]*** | [-3.33]*** | [-3.92]*** | [-4.04]*** | [-3.52]*** | [-3.64]*** |
| ASIZE | 0.238 | 0.186 | 0.277 | 0.399 | 0.241 | 0.358 |
| | [3.92]*** | [4.93]*** | [6.82]*** | [8.82]*** | [3.52]*** | [5.19]*** |
| HMFG | 0.092 | 0.039 | 0.028 | 0.069 | 0.084 | 0.017 |
| | [3.04]*** | [1.90]* | [1.37] | [3.22]*** | [2.13]** | [0.54] |
| HEDU | -0.006 | -0.017 | 0.002 | -0.011 | -0.041 | -0.041 |
| | [-0.41] | [-1.78]* | [0.18] | [-1.20] | [-2.05]** | [-2.67]*** |
| C | -12.453 | 10.227 | 9.593 | -9.569 | -9.425 | -9.085 |
| | [-6.81]*** | [8.27]*** | [7.83]*** | [-6.83]*** | [-5.68]*** | [-5.68]*** |

Note: 1) '*','**', '***' indicate statistical significance at 10, 5, 1 percent, respectively.

2) Random-effect probit model is used for estimation.

3) Figures in brankets indicate z-ratio.

4) Industry dummies, year dummies and regional dummies are included.

Source: Authors' estimattion

Table 4 The Determinatns of the Shift from Japanese to Local Staff: Total Industry

| Affiliates in | World | | | Asia | | | Developed Countries | | |
|---|---|---|---|---|---|---|---|---|---|
| Job | CEO | Sales | Procurement | CEO | Sales | Procurement | CEO | Sales | Procurement |
| # of obs | 1306 | 595 | 484 | 762 | 387 | 321 | 405 | 155 | 135 |
| POSALE | 0.443 | -0.080 | -0.347 | 0.409 | 0.167 | -0.536 | 0.621 | -0.002 | -0.255 |
| | [1.21] | [-0.21] | [-0.87] | [0.74] | [0.34] | [-1.03] | [1.00] | [-0.00] | [-0.35] |
| PSIZE | -0.011 | -0.083 | -0.053 | 0.062 | -0.102 | -0.063 | -0.116 | -0.033 | -0.003 |
| | [-0.28] | [-1.92]* | [-1.11] | [1.11] | [-1.97]*** | [-1.07] | [-1.32] | [-0.35] | [-0.03] |
| APROC | 0.054 | | -0.090 | 0.253 | | -0.100 | -0.380 | | -0.320 |
| | [0.32] | | [-0.47] | [1.11] | | [-0.42] | [-1.00] | | [-0.78] |
| ASALE | 0.055 | 0.385 | | -0.141 | 0.155 | | 0.114 | 0.667 | |
| | [0.33] | [2.23]** | | [-0.62] | [0.73] | | [0.34] | [1.72]* | |
| AAGE | 0.008 | 0.005 | 0.012 | 0.013 | 0.003 | 0.009 | 0.008 | 0.019 | 0.026 |
| | [1.03] | [0.71] | [1.39] | [1.11] | [0.25] | [0.76] | [0.60] | [1.38] | [1.63] |
| AEQY | -0.014 | -0.003 | -0.005 | -0.018 | -0.004 | -0.006 | -0.005 | 0.011 | -0.001 |
| | [-4.81]*** | [-0.81] | [-1.38] | [-4.87]*** | [-1.16] | [-1.49] | [-0.68] | [0.98] | [-0.11] |
| ASIZE | -0.082 | 0.071 | 0.070 | -0.173 | -0.028 | -0.085 | -0.054 | 0.150 | 0.201 |
| | [-1.73]* | [1.49] | [1.33] | [-2.36]*** | [-0.43] | [-1.16] | [-0.60] | [1.59] | [2.00]** |
| HMFG | 0.031 | 0.026 | 0.024 | 0.039 | 0.023 | 0.022 | 0.049 | 0.139 | -0.019 |
| | [2.47]** | [2.20]** | [1.86]* | [2.58]*** | [1.73]* | [1.53] | [0.66] | [1.25] | [-0.15] |
| HEDU | 0.022 | 0.024 | 0.029 | 0.049 | 0.024 | 0.027 | -0.029 | -0.011 | 0.027 |
| | [2.42]** | [2.48]** | [2.74]*** | [4.20]*** | [2.15]** | [2.03]** | [-1.14] | [-0.32] | [0.78] |
| C | -0.715 | -0.954 | -1.325 | -1.069 | -0.042 | -0.459 | 0.071 | -5.002 | -1.309 |
| | [-0.84] | [-1.08] | [-1.42] | [-1.07] | [-0.04] | [-0.42] | [0.04] | [-2.03]*** | [-0.43] |

Note: 1) '*','**', '***' indicate statistical significance at 10, 5, 1 percent, respectively.

2)Probit model is used for estimation.

3) Figures in brankets indicate z-ratio.

4) Industry dummies, year dummies and regional dummies are included.

Source: Authors' estimattion

Appendix Table 1 Basic Information on the Varibles used in the Analysis

| Categories | Variable Name | Explanation/Definition | Source | N | mean | sd | p25 | p75 |
|---|---|---|---|---|---|---|---|---|
| Overseas Affiliates | TT-CEO | Chief Executive Officer | METI, Kaigai Jigyo Kihon Chosa | 6502 | 0.211 | 0.408 | 0 | 0 |
| | TT-Deputy | Deputy CEO | METI, Kaigai Jigyo Kihon Chosa | 5603 | 0.403 | 0.491 | 0 | 1 |
| | TT-LAB | Labor management | METI, Kaigai Jigyo Kihon Chosa | 5877 | 0.683 | 0.465 | 0 | 1 |
| | TT-Acct | Accounting | METI, Kaigai Jigyo Kihon Chosa | 6115 | 0.577 | 0.494 | 0 | 1 |
| | TT-Sales | Sales | METI, Kaigai Jigyo Kihon Chosa | 5651 | 0.550 | 0.498 | 0 | 1 |
| | TT-Proc | Procurement | METI, Kaigai Jigyo Kihon Chosa | 5560 | 0.625 | 0.484 | 0 | 1 |
| | TT-R&D | Research and development | METI, Kaigai Jigyo Kihon Chosa | 2062 | 0.538 | 0.499 | 0 | 1 |
| | TT-Plan | Planning | METI, Kaigai Jigyo Kihon Chosa | 2762 | 0.572 | 0.495 | 0 | 1 |
| | APROC | Local procurement/total procurement | METI, Kaigai Jigyo Kihon Chosa | 6502 | 0.449 | 0.390 | 0.037 | 0.871 |
| | ASALE | Local sales/total sales | METI, Kaigai Jigyo Kihon Chosa | 6502 | 0.651 | 0.399 | 0.229 | 1 |
| | AEQY | Equity owned by Jap firms/total equi | METI, Kaigai Jigyo Kihon Chosa | 6502 | 0.835 | 0.240 | 0.65 | 1 |
| | AAGE | Length of operation | METI, Kaigai Jigyo Kihon Chosa | 6502 | 11.523 | 8.890 | 5 | 16 |
| | ASIZE | Ln (number of employees) | METI, Kaigai Jigyo Kihon Chosa | 6502 | 4.345 | 1.749 | 3.135 | 5.617 |
| Parent companies | POSALE | Overseas sales/Total sales | METI, Kaigai Jigyo Kihon Chosa | 6502 | 0.296 | 0.186 | 0.136 | 0.440 |
| | PSIZE | Number of employees | METI, Kigyo Katsudo Kihon Chosa | 6502 | 7.763 | 1.565 | 6.652 | 8.840 |
| Host countries | HMFG | Manufacturing VA/GDP | World Bank, World Development Indicators CD-ROM | 6502 | 0.234 | 0.079 | 0.176 | 0.309 |
| | HEDU | Secondary education attainment | Barro & Lee | 6502 | 17.044 | 7.541 | 12.35 | 22.28 |

Note: The value for technology transfer (TT) is unity, if the staff in charge of assignment is local. Otherwise, zero.
Source: Authors

Appendix Table 2 Correlation Matrix of the Variables

| | TT-CEO | TT-Deputy | TT-LR | TT-Acct | TT-Sales | TT-Purch | TT-R&D | TT-Plan | APROC | ASALE | AEQY | AAGE | ASIZE | POSALE | PSIZE | HMFG | HEDU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TT-CEO | 1 | | | | | | | | | | | | | | | | |
| TT-Deputy | 0.0109 | 1 | | | | | | | | | | | | | | | |
| TT-LR | 0.3038 | 0.2825 | 1 | | | | | | | | | | | | | | |
| TT-Acct | 0.3273 | 0.2703 | 0.589 | 1 | | | | | | | | | | | | | |
| TT-Sales | 0.3658 | 0.293 | 0.4521 | 0.4842 | 1 | | | | | | | | | | | | |
| TT-Proc | 0.2928 | 0.2535 | 0.5584 | 0.5505 | 0.6177 | 1 | | | | | | | | | | | |
| TT-R&D | 0.3539 | 0.2553 | 0.4337 | 0.4425 | 0.4916 | 0.5475 | 1 | | | | | | | | | | |
| TT-Plan | 0.3478 | 0.281 | 0.4687 | 0.4669 | 0.5541 | 0.5835 | 0.682 | 1 | | | | | | | | | |
| APCH | 0.1708 | 0.0288 | 0.0358 | 0.0748 | 0.0842 | 0.1081 | 0.057 | 0.0794 | 1 | | | | | | | | |
| ASALE | 0.1319 | 0.0613 | 0.1549 | 0.1017 | 0.1522 | 0.1312 | 0.0954 | 0.0937 | 0.0818 | 1 | | | | | | | |
| AEQY | -0.5133 | -0.104 | -0.2102 | -0.2387 | -0.2161 | -0.1708 | -0.1764 | -0.1794 | -0.2337 | -0.1475 | 1 | | | | | | |
| AAGE | -0.0103 | 0.0015 | 0.0028 | -0.0361 | 0.0364 | 0.015 | 0.0452 | 0.0445 | -0.0391 | 0.0985 | 0.0776 | 1 | | | | | |
| ASIZE | 0.0433 | -0.0546 | 0.1303 | -0.0745 | 0.0126 | 0.036 | -0.022 | 0.0211 | 0.0696 | -0.0776 | -0.1123 | 0.178 | 1 | | | | |
| POSALE | -0.0202 | 0.0002 | -0.0072 | -0.1042 | -0.0533 | -0.0739 | -0.0306 | -0.0116 | -0.1282 | 0.0987 | 0.0139 | 0.1282 | 0.2217 | 1 | | | |
| PSIZE | 0.0394 | -0.0352 | -0.0068 | -0.2029 | -0.0268 | -0.0802 | -0.0667 | -0.0901 | -0.0928 | 0.1122 | -0.0628 | 0.1306 | 0.2806 | 0.3395 | 1 | | |
| HMFG | 0.1163 | 0.0312 | 0.0746 | 0.0698 | 0.0226 | 0.008 | -0.0124 | 0.023 | 0.0758 | -0.1659 | -0.3305 | -0.223 | 0.2312 | -0.0838 | -0.0851 | 1 | |
| HEDU | 0.0417 | 0.0728 | 0.0098 | 0.0223 | 0.043 | 0.0818 | 0.0959 | 0.0418 | -0.0051 | 0.1067 | 0.1328 | 0.0744 | -0.1727 | -0.0051 | -0.0488 | -0.2823 | 1 |

Source: Authors' calculation