# What Determines Knowledge Sourcing From Host Locations of Overseas R&D Operations?: A Study of Global R&D Activities of Japanese Multinationals

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# What Determines Knowledge Sourcing From Host Locations of Overseas R&D Operations?: A Study of Global R&D Activities of Japanese Multinationals

## Abstract

We investigate factors that influence the extent to which characteristics of overseas R&D laboratories source knowledge from host locations. Drawing on both the capabilities perspective and the embeddedness perspective, we developed a conceptual model and then examined it empirically focusing on overseas R&D labs of Japanese multinationals. Statistical findings from negative binomial regressions show that both technological capabilities of the lab and external embeddedness in the local scientific and engineering communities matter.

Keywords: knowledge sourcing, overseas R&D, absorptive capacity, embeddedness

## INTRODUCTION

The globalization of research and development (R&D) is an important component of the ongoing trend towards globalization of the economy (Guellec & van Pottelsberghe de la Potterie, 2001). According to Gerybadze and Reger (1999), the degree of globalization of R&D measured by various indicators such as the proportion of R&D expenditure has increased substantially since the 1990s in most of the large R&D-intensive multinational corporations (MNCs). Zander (1994) found that in 1990, 40% of all technological activities of a sample of Swedish MNCs carried out abroad, while in 1980, about 30 % of them did the same. Kuemmerle (1999) also found that 32 large MNCs in the pharmaceutical and electronics industries in his survey undertook only 6.2% of their R&D efforts outside of their home countries' boundaries in 1965, but in 1995, the corresponding figure was 25.8%.

Moreover, recently, the nature of global R&D activities has evolved substantially in many leading MNCs from the traditional 'home-base exploiting (HBE)' ones to 'home-base augmenting (HBA)' ones (Kuemmerle, 1999). In other words, an increasing number of overseas R&D labs began to explore new knowledge from host locations and even globally beyond their traditional roles as exploiting and extending their existing technologies originally developed in their home countries. Such a trend is salient even among Japanese MNCs which are latecomers of R&D globalization as opposed to the US and European firms (Asakawa, 2001a).

As MNCs increase their global R&D efforts and upgrade roles of their overseas R&D labs, globalization of R&D has drawn growing attention from both academic scholars and practitioners. However, existing studies in this stream focused largely on economic and political aspects of R&D globalization, and thus, they offer little insight into how to manage overseas R&D activities. Penner-Hahn and Shaver (2000) contend that, despite the burgeoning literature that enjoins firms to globalize their R&D in order to access new technologies, we know little about the conditions that induce MNCs to do so. In addition, recent research on global R&D activities has largely "missed the opportunity for theoretical advancement that might arise from drawing upon more general theories of innovation and technological progress in organizations (Frost, 2001: 101)." Few investigate mechanisms affecting knowledge acquisition, development, and transfer in the global R&D activities.

In this paper, we seek to advance the study of global R&D activities by proposing and testing a model of how overseas R&D labs of MNCs source knowledge from host locations. To take a more theoretical and balanced perspective, we draw on both the capability perspective from evolutionary economics and the embeddedness perspective from organizational theory. Based on this multi-disciplinary framework, we develop hypotheses regarding overseas lab-level characteristics that influence the sourcing of knowledge from host locations.

Focusing on the home-base augmenting type of overseas R&D labs of Japanese multinationals, we collect data on these lab characteristics from both lab-level surveys and the U.S. patent data. We use US patent (citation) data to trace knowledge flows from host locations to overseas labs. We then employ negative binomial regressions to investigate factors influencing the level of knowledge sourced from host locations. Statistical results support our main hypotheses regarding both lab capabilities and external embeddedness into host locations.

## LITERATURE REVIEW AND THEORY

MNCs spend much of their R&D in foreign countries to develop links to local scientific and technical communities in order to source complementary knowledge (Florida, 1997). Yet, few studies have shown what factors affect how extensively MNCs source knowledge from these countries, even though such labs are apparently an excellent way for MNCs to outsource knowledge. In this section, we first analyze the characteristics and recent trends of global R&D activities of MNCs based on existing literature. Then, drawing on both the capability perspective and the embeddedness perspective, we propose a conceptual model of factors influencing the level of knowledge sourcing from host locations by overseas R&D labs.

## Literature Review

Recently, both the extent to which MNCs perform R&D outside their home countries and the types of R&D they do have changed considerably. During earlier periods of global expansion (the 1960s and 1970s), MNCs first built up foreign sales and manufacturing operations abroad. In later phases (late 1970s/early 1980s), efforts were directed towards supporting foreign subsidiaries with complementary design and development capabilities (Gerybadze & Reger, 1999). Although the trend towards R&D globalization had become apparent in the 1970s, it became a widespread phenomenon only as recently as in the late 1980s thanks to advances in information and communication technologies that served to connect dispersed R&D activities (Gassmann & von Zedtwitz, 1999). As of 1995, the ratio of overseas R&D to total R&D expenditures already exceeded 30% for European MNCs that were more proactive about foreign R&D activities than Japanese and American MNCs. According to the National Science Board (1996), between 1985 and 1993, overseas investment in R&D by US firms increased three times as fast as domestic R&D, while in the US, overseas R&D expenses reached 10% of overall R&D investment, up from 6% in 1985.

Further, although MNCs originally focused most of their foreign R&D on adapting technologies that they had developed at home to foreign production conditions (Hakanson, 1990), Dunning (1993) and Shan and Song (1997) found that MNCs have recently accelerated their efforts to explore and develop new technologies overseas. In a recent survey, almost 38% of overseas R&D labs was classified as 'home-base augmenting (HBA) R&D labs' seeking knowledge in host locations, while 62% of 'home-base exploiting (HBE) labs' still focused on exploiting and modifying technologies developed in the home countries of MNCs (Kuemmerle, 1999). In March (1991)'s terms, an increasing number of overseas R&D labs began to shift their main focus of learning from 'exploitation' to 'exploration.'

In response to the shift in the role of overseas labs, scholars began to focus more extensively on how MNCs use FDI not only to "push" or exploit their existing advantages in exploiting foreign markets but also to "pull" or explore new resources and capabilities from centers of innovation by acquiring or learning about complementary technologies (Shan and Song, 1997). When knowledge is sticky and remains confined within narrow geographical boundaries (Jaffe, Trajtenberg, and Henderson, 1991), a manufacturing or R&D location serves as an important source of competitive advantage (Almeida, 1996). Firms located in innovative regions such as Silicon Valley have greater access to new technological knowledge compared to their spatially distant counterparts. MNCs can develop competitive advantage by locating in overseas technological centers of excellence that offer differentiated streams of new knowledge, so long as they can learn to identify, transfer, and integrate the knowledge that they derive in host locations throughout their operations (Almeida, Song, and Grant, 2002).

Using industry-level data, empirical research supports the arguments that MNCs employ FDI to source knowledge. Cantwell (1989) found that MNCs are especially attracted to centers of innovation as a means of broadening their knowledge bases. At the firm level, Almeida (1996) found that U.S. subsidiaries of foreign MNCs use knowledge derived from the regions where these subsidiaries are located significantly more than U.S. firms from the same region. The result shows that MNCs in the semiconductor industry use FDI to access local information channels and source location-specific knowledge. Similarly, Shan and Song (1997) found that in the biotechnology industry, foreign MNCs invest in American biotechnology firms that patent frequently, thus sourcing country-specific, firm-embodied technological advantages. Almeida, Song, and Grant (2002) showed empirically that in the semiconductor industry, internal mechanisms within MNCs are more effective than are markets and alliances for transferring technology across borders.

However, few studies have investigated specific mechanisms or factors that influence the level of knowledge sourcing from host locations of overseas R&D labs. Recently, Asakawa (2002) proposed a conceptual framework for such mechanisms with a special emphasis on social capital, structural holes, and the resource-based view (RBV). Drawing on evolutionary economics and RBV, Song and Shin (2003) empirically examined factors influencing the level of knowledge sourcing from host locations of overseas R&D labs to headquarter R&D labs at home. In this study, we take one step further by investigating what factors determine knowledge flows from host locations to overseas R&D labs themselves.

## Theory and Hypotheses

To examine how characteristics of overseas labs influence the level of knowledge drawn from host locations in their innovative activities, we develop a conceptual model based on both the capability perspective derived from evolutionary economics and the embeddedness perspective derived from the social capital theory. Evolutionary economics views a firm as a set of unique routines and capabilities (Nelson and Winter, 1982). Accordingly, the type and level of firm capabilities at a certain point of time in the evolutionary process would influence a firm's behavior such as organizational learning and innovation in the subsequent period. On the other hand, the social capital view of organizational theory highlights the role of inter-firm or inter-personal relations in organizational learning and innovation (Burt, 1992). Valuable knowledge is often embedded in social relations and structures (Granovetter, 1985). Thus, how a firm is embedded in a larger community or network that it belongs to often exerts a significant influence on learning and innovation (Saxenian, 1994; Andersson, Forsgren and Holm, 2001). Thus, to take a more balanced, multi-disciplinary view, we draw on both the capability perspective and the embeddedness perspective. Figure 1 summarizes our conceptual model.

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Insert Figure 1 about here

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**Lab Capabilities and Sourcing of Local Knowledge.** We first develop a hypothesis based on the capability perspective. Among various firm-level factors that influence MNCs' propensity to source knowledge from host locations of overseas R&D labs, MNCs' technological capabilities, especially those of their overseas R&D labs, seem to be most important. To identify, acquire, and assimilate valuable external knowledge, especially tacit knowledge, a firm must possess considerable absorptive capacity (Cohen and Levinthal, 1990) in related technological areas. Cumulative experience with a technology often determines the recipient's absorptive capacity to acquire such tacit knowledge. Firms seek to acquire knowledge externally when there is a significant knowledge gap between them and industry leaders. Yet firms that develop substantial cumulative experiences and knowledge bases are better positioned to acquire target technologies (Leonard-Barton, 1995).

The absorptive capacity view suggests that MNCs with strong technological capabilities at both the overseas lab level and the headquarter level are superior in assimilating and extending knowledge sourced from host locations. Penner-Hahn and Shaver's analysis of international R&D expansions by Japanese pharmaceutical firms (2000) found, for instance, that firms benefit from international R&D when they possess existing technological capabilities in underlying technologies. The absorptive capacity view implies that the level of knowledge sourced from host locations should be higher in MNCs with strong technological capabilities than it is in MNCs with weak technological capabilities, especially at the lab level.

Frost (2001) showed that the strength of a lab's technological capabilities would predict whether the lab-level innovation builds upon home or host country ideas. Overseas R&D labs with weak technological capabilities tend to rely more on knowledge transferred from parent company labs at home. However, as an overseas lab improves its technological capabilities and absorptive capacity, it would be more likely to seek knowledge resided in the host location more actively as a basis of its innovative activities up to a certain point. Similarly, Håkanson and Nobel (1993) suggested that the technological orientation of overseas R&D labs may evolve over time toward a more autonomous set of activities that are less closely aligned to the existing knowledge base of the parent firm, as they improve their own technological capabilities.

However, above a certain threshold level of lab capabilities, an overseas R&D lab with strong technological capabilities may upgrade itself from the 'local R&D lab' that seeks knowledge of the host location mostly to the 'international R&D lab' that explores knowledge globally beyond the boundary of the host location (Medcof, 1997; Nobel & Birkinshaw, 1998). The international R&D lab is typically a "contributor" in Asakawa (2000)'s stage model of overseas R&D labs. In his model, the headquarters of an MNC assign a "contributor" role to a highly competent overseas lab so that it can pursue innovative activities for the entire global network. Such a lab would integrate knowledge sourced not only from the host location, the parent firm and the home country, but also from other parts of the world in an effort to develop non-location-bound advantages (Rugman and Verbeke, 2001).

For example, overseas R&D labs of such Japanese companies as Canon, Hitachi, Sharp, Kobe Steel, and Eisai evolved from a local innovator to a global-scale contributor which draws not only on locally sourced knowledge but regionally sourced knowledge beyond the national border (Asakawa and Lehrer, 2003). According to Asakawa and Lehrer, many European R&D centers of Japanese firms play a role of the "regional innovation relays", i.e. sensing and extracting regionally-dispersed R&D resources and relaying them for the global use. In this process, both Canon and Hitachi's R&D globalization has evolved similarly: from phase one for R&D localization through phase two for contributing to local business units to phase three for global contributors by integrating overseas R&D activities into corporate R&D strategies (Kozato, 2001; Asakawa, 2001a).

Hence, we propose an inverted U-shaped relationship between technological capabilities of an overseas lab and the level of knowledge sourcing from the host location.

*Hypothesis 1: The level of knowledge sourcing from the host location is likely to increase and then decrease as an overseas R&D lab enhances its technological capabilities.*

**Embeddedness and Sourcing of Local Knowledge.** The second perspective that we take is the social capital view of organizational theory that highlights the role of inter-firm or inter-personal relations in organizational learning and innovation. The central proposition of social capital theory is that networks of relationships constitute a valuable resource for the conduct of social affairs, providing their members with the collectively-owned capital (Bourdieu, 1986).

According to Nahapiet and Ghoshal (1998), the social capital often plays an important role in the development of the intellectual capital because new knowledge is created through a complex social process of combination and exchange of existing knowledge. As a result, valuable knowledge is often embedded in social relations and structures (Granovetter, 1985) and acquisition and utilization of such knowledge are also a social process (Kogut & Zander, 1992).

Thus, how a firm is embedded in the larger community or social network which it belongs to often exerts a significant influence on learning and innovation (Saxenian, 1994). According to Andersson, Forsgren and Holm (2001), the degree of embeddedness in the host location influences the innovative capacity of overseas subsidiaries.

In this respect, we focus on the embeddedness aspect of the social capital theory. Uzzi (1996) defines embeddedness as closeness in a relationship that reflects the intensity of information exchange and the extent to which resources between the parties in the dyad are adapted. When it comes to an overseas R&D lab, the type of social networks in which the lab is embedded are two sided:(1) an external network with research & engineering communities (e.g., universities, research institutes) in the host location and (2) an internal network within an MNC (Asakawa, 1996a). We call the former type of embeddedness an 'external embeddedness.' Although the latter type of a network consists of all the units in the firm, we view the headquarter-lab relation as the most representative form of embeddedness. We call this type of embeddedness an 'internal embeddedness.' Due to the conflicting isomorphic pressures (Rosenzweig and Singh, 1991), the type and level of external or internal embeddedness could facilitate or inhibit social behaviors (Nahapiet & Ghoshal, 1998) such as a lab's propensity to source local knowledge. Along this line, we develop specific arguments regarding the effects of external and internal embeddedness on the sourcing of knowledge from host locations by an overseas R&D lab.

**External Embeddedness**. Due to a liability of foreignness (Hymer, 1976), an overseas subsidiary often encounters significant entry barriers to the knowledge network in the host location. However, to obtain contextual and location-specific knowledge, an overseas R&D lab should be embedded in the local scientific and engineering communities for more close interactions with them. The two-way interaction afforded by a strong tie is often important for assimilating tacit knowledge, because the recipient most likely does not acquire the knowledge completely in the first interaction but needs multiple opportunities to assimilate it (Szulanski, 1996; Hansen, 1999). Ghoshal and Bartlett (1990) contended that local isomorphism in the form of embeddedness is essential to the acquisition of local knowledge because it allows the lab to gain legitimacy from the local communities. Moreover, embedding an overseas lab more closely in the local communities allows the lab to develop similar knowledge-processing systems as local research collaborators as a basis of enhanced absorptive capacity (Lane & Lubatkin, 1998).

For example, Hitachi's Cambridge Lab was given its nickname, the "embedded laboratory," by Dr. Broers, Vice Chancellor of Cambridge University, for its extensive research collaboration with scientists at the university. Similarly, Mitsubishi Electric's labs in the U.S. have generated research outputs based on extensive research collaborations with such US universities as University of North Carolina for the animation technology and SUNY for the 3D Volume Graphics. In the process, Mitsubishi Electric's US labs frequently exchanged engineers and scientists with these universities.

Hence, we hypothesize:

*Hypothesis 2: An overseas R&D lab is more likely to source knowledge from the host location when it is embedded in the local scientific & engineering communities more deeply.*

**Internal Embeddedness**. As an overseas R&D lab is a subsidiary of an MNC, the embeddedness in the global network of the MNC, especially the type of relationship with the corporate headquarter, exerts an importance influence on the level of knowledge sourcing from the host location. Asakawa (1996a) argues that strong internal linkages of an overseas lab to the headquarters tend to influence behavioral and cognitive patterns of actors in overseas labs, and the isomorphic pressure from the headquarters would be counter-productive in accessing location-specific knowledge. While the overseas R&D lab requires autonomy to foster creativity and new idea generation, the parent firm often demands coordination and control of overseas R&D activities (Ronstadt, 1977; Kuemmerle, 1996, 1997). In his extensive survey of the relationship between overseas R&D labs and parent firms in Japan, Asakawa (2001b) found that strong internal connectivity or embeddedness constrained autonomy of Japanese overseas labs, thereby lowering the level of knowledge sourcing from host locations. Hence, we hypothesize:

*Hypothesis 3: An overseas R&D lab is less likely to source knowledge from the host location when it is embedded in the internal network of the MNC more deeply.*

## METHOD

### Data

To test hypotheses empirically, we focus on the home-base augmenting type of overseas R&D labs of Japanese MNCs. Japanese MNCs have recently increased their overseas R&D activities substantially (Belderbos, 2001). The sample in our empirical research was drawn from Asakawa (1996b)'s survey conducted in 1995.[1] Asakawa made extensive surveys of 81 overseas R&D labs of 46 major corporations in Japan. In our analysis, we included labs with patents registered in the U.S. only.[2] This is because our research focuses on the home-base augmenting type of overseas R&D labs that can produce patents as an outcome of innovative activities. As a result, we included 26 labs from 17 Japanese MNCs. These labs are located either in the U.S. or Europe. Following the classification scheme of U.S. Patent & Trademark Office (USPTO), we

[1] His sample selection criteria were as follows: the labs were at least one year old as of 1995; they had at least five staff; and they conducted research activities in one of the following areas – basic research, applied research, and development.

[2] Because a firm must patent in a specific country to gain intellectual property protection in that country, and because the U.S. is the world's largest technology market, non-U.S. firms routinely file patents in the U.S. (Albert, Avery, Narin, and McAllister, 1991). Thus, we use the US patent data for more objective comparisons of patent counts of MNCs from various countries with different intellectual property regimes.

defined host locations as states in the case of labs in the U.S. and countries in the case of labs in Europe, respectively.

We collected data on these lab characteristics from both lab-level surveys conducted by Asakawa and the U.S. patent data. We used the survey data to construct variables regarding embeddedness. Following Hall, Jaffe, and Trajtenberg (2000), Ahuja and Katila (2001), Song, Almeida, and Wu (2003) and others, we used U.S. patent data to measure technological capabilities.

To construct a dependent variable, we used US patent citation data. A patent document contains a host of information, including citations to other patents. The list of citations for each patent is arrived at through a uniform and rigorous process applied by the patent examiner as a representative of the patent office. The patent applicant and her lawyer are obliged by law to specify in the application any and all of “the prior art” of which she is aware. The list of patent citations so compiled is available on the patent document, along with information on the patenting firm, inventor, geographic location, and technology types. In principle, a citation of *Patent X* by *Patent Y* indicates that *Patent Y* builds upon previously existing knowledge embodied in *Patent X*. Based on this premise, a series of recent articles have used patent citation data to track knowledge flows (Jaffe, Trajtenberg, and Henderson, 1993; Almeida, 1996; Almeida, Song, and Grant, 2002; Song, Almeida, and Wu, 2003; Song and Shin, 2003). Thus, through patent documents, one can infer both organizational and technological influences on a particular invention and thus track knowledge building across people, firms, geographic regions and countries, and time. Using the patent citation data, we traced knowledge flows from host locations to overseas labs.

The unit of analysis in the negative binomial regression is individual patents granted to these 26 R&D labs in our sample. Using our proprietary data on all patents filed in the U.S. from

1973 through 1999, we retrieved 1043 patents granted to these labs. Among these 1043 patents, for our dependent variable in the regression analysis, we used 284 patents filed by (and then granted to) these labs since 1996 as Asakawa's survey was conducted in 1995. Considering time spent to complete a research project that produces patents, we gave a time lag of at least one year from the survey time point. Patents filed by 1995 were used to measure technological capabilities of each lab.

**Methods and Variables**

We employ negative binomial regressions to investigate the factors influencing the level or the magnitude of knowledge sourced from host locations where overseas R&D labs were set up. As an extension of the Poisson regression, a negative binomial regression is used to estimate models of occurrences (counts) of an event when the event has extra-Poisson variation in the form of overdispersion.  In our negative binomial models, the probability that the number of patent citations will occur n times (with n = 0, 1, 2,…) is as follows:

$$\text{Prob}\ (Y = yj) = e^{-\lambda j} \lambda_j^{Yj}\ /\ Y_j\ !$$

Where $\lambda_j = \exp\ (\sum B_i X_{ij})\ \exp\ (\mu_j)$ and $e^{\mu j} \sim\ \ \text{Gamma}\ (1/\alpha,\ 1/\alpha)$

For observed counts of patent citations $Y_j$ with covariates $X_i$ for the jth patent of an overseas R&D lab i.

The dependent variable, measured at the patent level, represents the extent of knowledge sourced from the host location. The variable is operationalized as the number of citations that each patent makes to any patent from the host location.  An increase in this measure indicates an increase in the degree to which a patent builds upon knowledge from the host location of the overseas R&D lab.

As for independent variables, technological capabilities of an overseas R&D lab (Hypothesis 1) are operationalized as the number of US patents granted to the lab prior to the file date of a specific patent. Thus, the proxy measure is time varying. To standardize the variable, we took a log scale.

Following a method suggested by Pugh and Hickson (1976), the degree of external embeddedness (Hypothesis 2) was measured by a composite index that was created based on Asakawa's survey in 1995. The survey included questions regarding interactions with local scientific communities (such as local university, other research institutions, and local firms) in the form of research contracts, journal publications, joint appointments and so on. A proxy measure of the internal embeddedness (Hypothesis 3) was computed in the same way. We used questions from the Asakawa's survey to identify the degree of the parent's involvement in the way the decisions such as recruitment and performance appraisal of an overseas R&D lab are made. Because items are measured using the 5-point Likert scale, we averaged scores from questions. The higher the score of the internal embeddedness is, the more deeply the overseas R&D lab is embedded in the parent firm network. We tested inter-item reliability for external and internal embeddedness composite indexes respectively by computing Cronbach's Alpha and found that inter-item reliability is high enough to construct composite indexes for both variables.

As for control variables, we included the total number of citations made by a sample patent since it influences the extent of citations to the host location. In other words, the more the total citations made by each patent, the more likely for the patent to cite any patent from the host location. We also controlled for technological capabilities of the host location. Song and Shin (2003) found that MNCs are more likely to source knowledge from host countries when their host countries have stronger technological capabilities than their home countries. To measure technological capabilities of the host location, we counted the total number of patents granted to the host location in the past 10 years prior to the application year of the overseas R&D lab patent in our sample and then took the log scale. We also controlled for technological capabilities of the parent company in the same way. Both capability variables are time varying variables. Finally, we also added industry dummies to control for possible industry differences.

## RESULTS

Table 1 presents descriptive statistics. To check multi-collinearity problems among the variables, we computed variance inflation factors but could not find any troubling collinearity. Thus, we included all variables in regressions. Table 2 summarizes the statistical findings from the negative binomial regressions. Table 2 includes both the base model with control variables only and the full model. The log-likelihood ratio of the full model was significantly improved from the base model and thus, we used the full model for statistical interpretations.

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Insert Tables 1 and 2 about here

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In the full model, the coefficient of the quadratic term of technological capabilities of the overseas R&D lab was highly significant and negative while the coefficient of the linear term was significant and positive, suggesting the inverted-U shaped relationship. This result supports hypothesis 1 suggesting that overseas R&D labs outsource knowledge from the host location more as technological capabilities increase up to a certain point and then they outsource less beyond a certain threshold level. External embeddedness was also highly significant and positive. This finding lends support to the idea that an overseas R&D lab that is embedded more deeply in the local scientific & engineering communities is more capable and likely to source knowledge from the host location. However, internal embeddedness (hypothesis 3) was not significant.

Among the control variables, both the total number of citations made by the sample patent and technological capabilities of the host country turned out to be highly significant and positive, as expected. Technological capabilities of the headquarters were also marginally significant. However, industry dummies were not significant.

To confirm the robustness of our results, we conducted a sensitivity analysis. In a supplementary analysis, we modified our dependent variable slightly by excluding self-citations made to prior patents of these labs themselves from the citations made to patents from the host location including self-citations. Results were mostly the same as our main analysis. In this supplementary analysis, the magnitude and significance of regression coefficients became even higher.

## DISCUSSION AND CONCLUSIONS

The intended contribution of the study is to examine the conditions under which an overseas R&D lab is more likely to outsource knowledge from the host location. The results of the statistical tests support our hypotheses 1 (lab capabilities) and 2 (external embeddedness). However, our hypothesis regarding internal embeddedness was not supported statistically. This paper suggests some theoretical and practical implications.

In addition to addressing a previously unexplored empirical question, this paper advances the theory of how MNCs learn from technology-seeking FDI. An intriguing argument and finding from this study is that there exists an inverted-U shaped relationship between technological capabilities of the overseas R&D lab and the degree of knowledge sourcing from the host location. Such a finding has implications for research in globalization of R&D activities, which stresses the importance of external knowledge to innovation. The absorptive capacity view suggests that MNCs with strong technological capabilities are superior in assimilating and extending knowledge sourced from overseas R&D labs, thereby proposing a positive linear relationship between technological capabilities of the lab and knowledge sourced from the host location (Frost, 2001).

However, unlike conventional arguments regarding absorptive capacity, our statistical results show that the linear relation would not hold above a certain threshold level of lab capabilities. Our results indicate an evolution of the role of an overseas R&D lab, in consistent with observations made by such scholars as Medcof (1997), Nobel & Birkinshaw (1998), and Asakawa (2001a). According to Asakawa and Lehrer (2003), leading Japanese firms such as Canon, Hitachi, Sharp, and Toshiba upgraded the role of major R&D labs in Europe as facilitating “regional-for-global” innovation. Though they are predominantly located in U.K., these labs are not considered as local units. These firms now face a challenge of how to integrate their regionally-pooled knowledge assets into the parent firms’ global innovation networks.

As these observations suggested, an MNC headquarters may have incentives to transform technologically competent overseas R&D labs from the ‘local R&D lab’ that seeks knowledge of the host location mostly to the ‘international R&D lab’ that explores knowledge globally beyond the boundary of the host location. ‘The international R&D lab’ with a global R&D mandate would integrate knowledge sourced not only from the host location but also from the rest of the world. For example, Mitsubishi Electric’s US laboratories, while being embedded in local research clusters, continue to source knowledge through a wide scope of interactions with local universities within their regions as well as with major universities from other countries.

This finding may suggest some managerial implications. The evolution towards the international R&D lab would be made possible by hiring and developing highly capable researchers who can learn and innovate on a global basis. To secure such globally competent researchers, the MNC headquarters should give substantial autonomy to the overseas R&D lab in the early stage of the evolution so that it can develop independent research capabilities. Asakawa (2001b) found that unless the substantial autonomy is granted to an overseas R&D lab, it is difficult for the lab to hire and retain talented local researchers. However, after the lab develops a strong independent research capability with highly competent researchers, the corporate headquarters should consider upgrading the role of the lab accordingly from the local lab to the international lab with a global R&D mandate.

Our results also show that sourcing knowledge from the host location is more likely when an overseas R&D lab is embedded more deeply in the local scientific and engineering communities. The importance of external embeddedness in the local communities suggests a positive effect of social capital on learning. The result is consistent with Almeida (1996)'s argument that in order to learn from the host location, MNCs should tie themselves into the local social networks and hire engineers locally. Thus our finding that confirms the importance of external embeddedness in learning from the host location advances the existing literature on the globalization of R&D.

Empirically, we believe that this is the first attempt to investigate systematically how characteristics of overseas R&D labs can influence knowledge sourcing from the host location. In this study, drawing on both the primary data – lab-level surveys – and the secondary data -- U.S. patent data, we employed direct measures of lab capabilities and embeddedness, unlike most prior studies that used case studies due to data constraints. Moreover, unlike most previous empirical studies of knowledge-seeking FDI, this paper attempted to measure the degree of knowledge sourcing from the host location more directly by tracing the level of knowledge flows captured by patent citation counts. Furthermore, by taking multiple theoretical perspectives -- the capabilities perspective from evolutionary economics and the embeddedness perspective from organizational theory, this paper offered more comprehensive and balanced understanding about the globalization of R&D that is becoming more essential to the competitive advantages of MNCs.

However, this paper has some limitations. Primarily, due to the data constraints, we could not conduct research using the lab *per se* as a unit of analysis and instead, we used patents from the lab as the unit of analysis.

Figure 1

Research Model

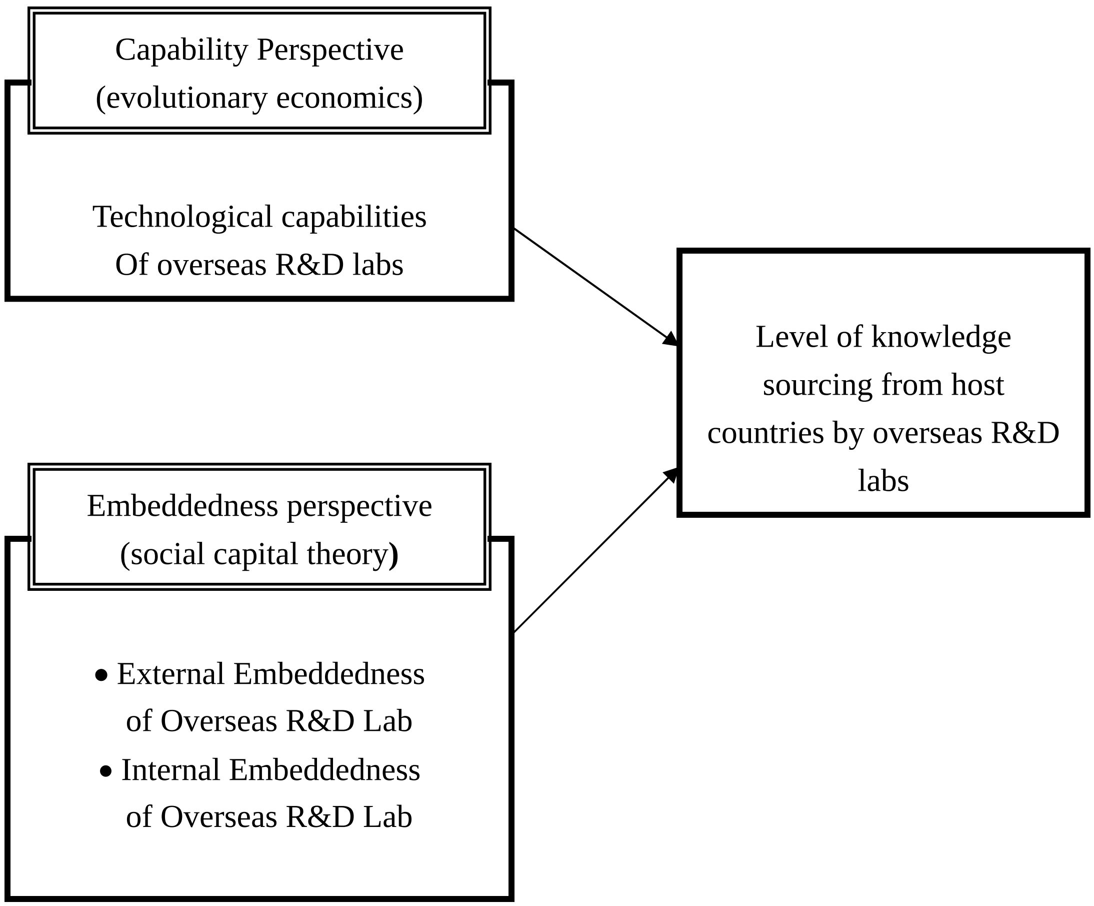

Table 1

Summary of Descriptive Statistics (N=284)

| Variable | Mean | Standard Deviation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Knowledge sourced from the host location | 1.5422 | 2.5982 | 1.0000 | | | | | | |
| 2. Log (Technological capabilities of the overseas R&D lab) | 4.0781 | 0.9224 | -0.0582 | 1.0000 | | | | | |
| 3. External embeddedness of the overseas R&D lab | 1.6267 | 0.6840 | 0.1342* | 0.2211* | 1.0000 | | | | |
| 4. Internal embeddedness of the overseas R&D lab | 2.8661 | 0.9072 | 0.0399 | 0.1819* | -0.0921 | 1.0000 | | | |
| 5. Total number of citations per patent | 9.2394 | 10.9334 | 0.6149* | 0.0519 | 0.1136 | -0.0260 | 1.0000 | | |
| 6. Log (Technological capabilities of the host location) | 10.5562 | 0.5724 | 0.2442* | -0.0384 | 0.0207 | -0.0721 | 0.1652* | 1.0000 | |
| 7. Log (Technological capabilities of the MNC headquarter) | 7.7706 | 1.8993 | 0.0382 | 0.3658* | -0.3630* | 0.2563* | 0.0276 | 0.0753 | 1.0000 |

* significant at $p<0.05$

Table 2

Statistical Results from Negative Binomial Regression (N=284)

| | Base Model | Full Model |
|---|---|---|
| (Constant) | -8.537576*** (1.935175) | -9.237768 (1.904459) |
| Control Variable | | |
| Total number of citations per patent | 0.0542004*** (0.0067279) | 0.048967*** (0.0060252) |
| Log (Technological capabilities of the host location) | 0.8107567*** (0.1867623) | 0.6516859*** (0.1713759) |
| Log (Technological capabilities of the MNC headquarter) | -0.0260476 (0.0728781) | 0.1387545* (0.077072) |
| Industry dummy (electronics/semiconductor) | -0.2199234 (0.5780812) | -0.0325395 (0.5780712) |
| Industry dummy (chemical/pharmaceutical) | -24.99709 (106771) | -20.05903 (6373.999) |
| Independent Variable | | |
| Log (Technological capabilities of the overseas R&D lab) | | 0.6076047* (0.3684772) |
| **H1** [Log (Technological capabilities of the overseas R&D lab)]$^2$ | | -0.1410829*** (0.0538499) |
| **H2** External embeddedness of the overseas R&D lab | | 0.7204782*** (0.1549818) |
| **H3** Internal embeddedness of the overseas R&D lab | | -0.0946758 (0.0950446) |
| Goodness of Fit (Log-likelihood) | -419.49413 | -399.66877 |

1) *significant at $p < 0.1$, **significant at $p < 0.05$, ***significant at $p < 0.01$

2) Standard Errors in Parentheses

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