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知識スピルオーバーから見た日米多国籍企業における中国への進出戦略の比較

A Comparison of the Location Strategies of U.S. and Japanese Multinationals in a View of Knowledge Spillovers

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要　旨

多国籍企業にとって外部との連携研究は重要であり、本論文は連携によって発生する知識スピルオーバーと多国籍企業の中国進出に関する立地選好間の関係を条件付きロジスティック回帰モデルで分析した。知識スピルオーバーが特許引用と外国直接投資（FDI）に直結するため、米国特許商標局に登録した特許データ及び中国統計年鑑による立地属性データを分析し、多国籍企業と連携する中国人発明者の所在地の分布がその地域の特許件数（R&D 強度）及び FDI 件数（FDI 強度）の分布と近接することを明らかにした。さらに、日本企業は R&D 強度のより高い地域に連携し、米国企業は立地選好をより集中して FDI 強度のより高い地域に連携することを理解した。加えて、多国籍企業の立地選好戦略は、中国の地理的な R&D 強度及び FDI 強度の観点から見ると、知識スピルオーバーの流入及び流出と関連することがわかった。

キーワード：知識スビルオーバー，外国直接投資，R&D 連携，特許データ，多国籍企業

ABSTRACT

Given the importance of external research collaboration for multinational enterprises (MNEs), we examine the pace of knowledge spillovers and analyze MNEs' location strategies for research collaboration in China by doing conditional logit estimation. As knowledge spillovers are associated with patent citations and foreign direct investments (FDIs), we find, by analysis of USPTO patent data and statistical data of regional economy, that the geographical distribution of MNEs' research collaborators is positively associated with the distributions of local R&D intensity (patent stock) and FDI intensity (firms with FDI). Other results suggest that Japanese MNEs collaborate more closely based on the distribution of SIPO patent stock, while U.S. MNEs collaborate more narrowly and closely based on the distribution of firms with FDI. The findings further illustrate that MNEs' location strategies are associated with not only inward knowledge spillovers but also outward knowledge spillovers in terms of geographical R&D intensity and FDI intensity in China.

Keywords: knowledge spillovers, foreign direct investment, R&D collaboration, patent data, multinational enterprises

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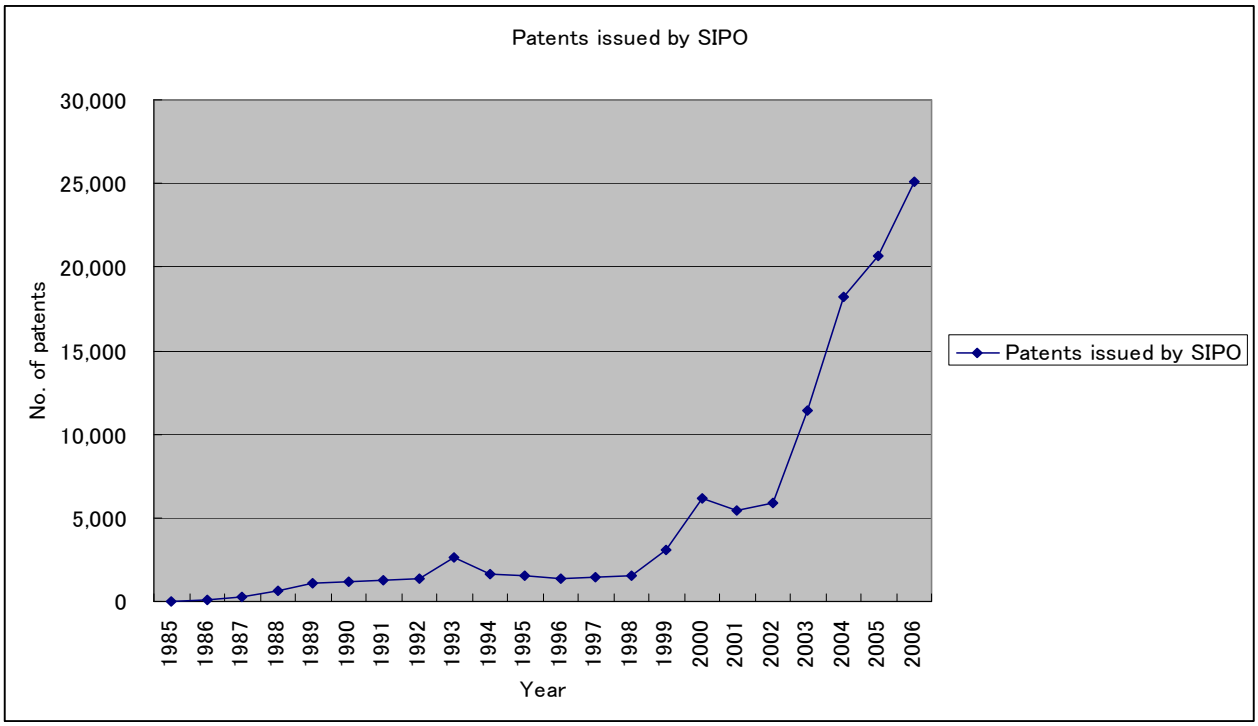

Figure 1. Number of yearly patents(in terms of type invention) issued by SIPO
Data source : China Statistical Yearbook 1986-2007

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1. Introduction

A recent trend has prevailed to move factories across national boundaries to foreign locations to manufacture products in the most efficient way. This trend has also extended to service industries, including R&D. It is essential to understand how multinational enterprise (MNE) pioneers developed location strategies to move activities globally, and what location factors might possibly influence decisions made according to empirical studies for future followers. MNEs meet various challenges in foreign countries with different institutional environments (Powell & DiMaggio, 1991; Scott, 1995), especially in emerging economies, which lead to, for instance, many more opportunities to enjoy from in-bound knowledge spillovers to formulate R&D capability for organizations with good absorptive capacity (Cohen & Levinthal, 1990). However, MNEs still simultaneously suffer great risks of out-bound knowledge spillovers that might lead to losing competitive advantage. Thus, we analyze MNEs' R&D activities to explore how they accommodate for knowledge spillovers. We suggest to MNEs that are deeply involved in overseas research collaboration how to avoid potential business risks in emerging economies, such as China, as this is an important issue for the management of technology (MOT).

China's GDP was calculated at $3.4 trillion in 2007, and ranked the 3rd highest in the world, with a growth rate of 13% (World Bank). Rapid economic growth has made China a country difficult to ignore, and it has recently been in the spotlight. Furthermore, the technology market in China grew at a rate that was as high as the R&D growth rate (Motohashi, 2005). Since the Resolution of the Central Committee of the Communist Party initiated reform of the science and technology (S&T) system

in 1985, several S&T-related regulations were promulgated and implemented between 1985-1995. Registered patents increased dramatically after the S&T system reform (Figure 1). Thus, such change presents a great opportunity to examine knowledge spillovers in the rapidly growing Chinese market.

This paper focuses on patent data to examine how opportunities for knowledge spillovers observed through various institutional conditions, including patent stocks or degree of foreign direct investment (FDI), affect MNEs' locational selection of collaborators in the host country (China). The geographical distribution of patent inventors or assignees can be used as an indicator for examining the existence of research collaboration (Chung and Alcacer (2002, 2007) and Singh(2007, 2008)). Thus we examined the joint co-patenting between U.S. or Japanese firms and Chinese researchers as an indicator for R&D collaboration and compared the effects of various instiutional conditions that reveal knowledge spillovers for the locational selection of collaborators.

In this paper, following this section, Section 2 reviews the extant literature on knowledge spillovers and its relationship with patent data and FDI as the theoretical framework of MNEs' overseas research collaboration. Section 3 describes the methodology and explains how data are collected. Section 4 shows the analytical results and discusses how environmental factors affect MNEs' location choices in China. Finally, Section 5 concludes by discussing the difference between the location strategies of Japanese and U.S. MNEs, and suggests MNEs for future research collaboration in China.

2. Theoretical Background

In accordance with the advancement of the global economy, MNEs have widely implemented R&D collaboration, which is not confined within their home country, out of consideration of cuts in employee wages and the availability of high-quality researchers due to the economic rationality. When R&D collaboration or FDI happens, knowledge is transferred across regionnal borders or organizational boundaries as "spillovers" intentionally or unintentionally. If the transferred knowledge is limited to what the contract covers, the transfer itself is the desired effect. The knowledge transfer process and the execution of externally acquired knowledge involves a complicated process and uncertainty. In many cases, knowledge will spillout to an undesired party, or undesired knowledge will spillout to collaborators. For instance, knowledge spillovers occur especially through employees' moving from MNEs to local firms (Pack & Saggi, 1997; JBIC, 2002).

Since, in an advanced knowledge economy, the existence of undesired spillovers may undermine comparative advantage, the selection of the location of the collaborator as well as the selection of the collaborator itself is crucial. Conversely, the incoming, unintentional knowledge flow may play an important role in a highly competitive market. Based on these circumstances, an MNE's locational strategy for choosing a partner is affected by the pros and cons of the knowledge spillover in relation to the MNE's competitive advantage.

The existence of knowledge spillovers were evaluated quantitatively by Jaffe et al (1993). They showed that inventors are more likely to cite others who are geographically closer. In order to study the mechanism of knowledge transfer between an MNE and a host country, Singh (2007) used USPTO patent bibliographic information to quantitatively evaluate the degree of knowledge spillovers from a host country and an MNE, and showed that those flows are not unidirectional, but rather, there is a non-negligible knowledge flow from the host country to the MNE's home country.

Alcacer & Chung (2007) and Nachum et al. (2008) researched knowledge spillovers and location choices in relation to FDI activities. Alcacer & Chung (2007) pointed out how the cost of outward knowledge spillovers affects firms' location choices. Although their work has goals similar to those of the present paper, the domain is limited to the U.S., as micro-level data on overseas collaboration is not available in non-U.S. countries in general.

3. Data and Method

In order to choose the sample of U.S. and Japanese MNEs that incorporate R&D collaboration in China, we retrieve the data set from the USPTO patent database by using a query that limits the result to "include at least one China-resident inventor," and "include at least one assignee that resides in Japan or the USA" to obtain 127 and 561 patents for each country. Each patent is treated as an example of

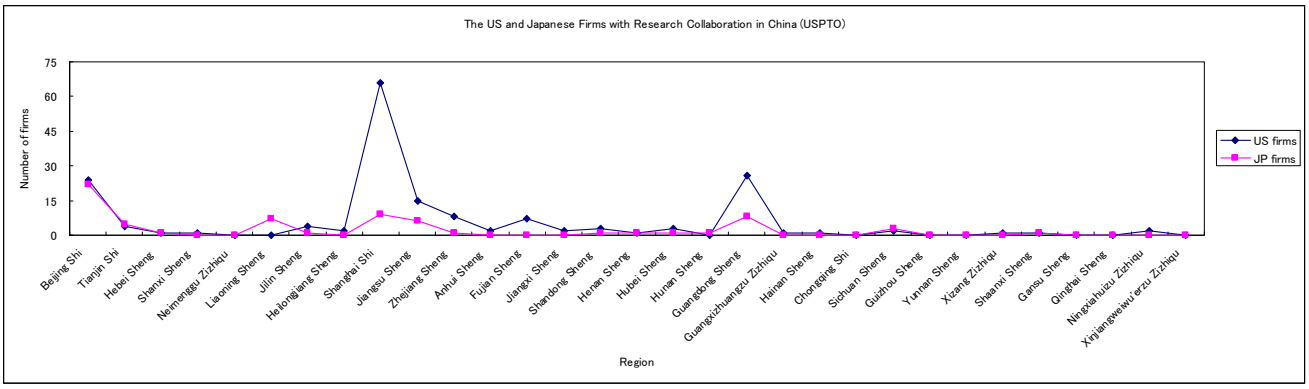

Figure 2. MNEs in research collaboration in China by region(data retrieved from USPTO)

research collaboration. After sorting patents by MNE, we select the first patent[1] of each MNE and delete the unqualified data[2]. Finally 49 Japanese MNEs and 134 U.S. MNEs are selected for this study. This criterion means that an MNE establishes its first research collaboration between itself and Chinese inventors. The address of a Chinese inventor determines MNE's research collaboration for the location selection. We assume that the province-level location is a node of knowledge spillovers, as knowledge will diffuse by the Chinese inventors to the other provinces, and may spillover bilaterally between the MNE and local firms.

In further analyzing the distribution of knowledge spillovers, and the relation between patents and FDI, our research collects the location data of the 31 locations from the China Statistical Yearbook (1986- 2007). We assume that the number of patents registered to the State Intellectual Property Office of the P.R.C. (SIPO) in a province indicates the local R&D intensity of province, and that the number of firms founded by FDI in a province indicates the FDI intensity of province. We then classify the data set into four categories by province, as A) US-Firms: the number of U.S. firms in collaboration with Chinese inventors in a province. B) JP-Firms: the number of Japanese firms in collaboration with Chinese inventors in a province. C) FDI-Firms: the number of firms founded by FDI in a province by year. D) SIPO-Patents: the number of patents, in terms of invention, registered in SIPO in a province by year.

4. Results and Discussion

4.1 Geographical distribution of MNEs' collaboration destination

Figures 2 and 3 are converted from the collected data sets. In Figure 2, there are three peaks, indicating that MNEs collaborate with Chinese inventors mainly at Beijing in the North, at Shanghai, Jiangsu, and Zhejiang in the East, and at Guangdong in the South. In Figure 3, there are also three peaks of the SIPO patents and firms with FDI: Beijing in the North, Shanghai in the East, and Guangdong in the South, indicating that patents and firms with FDI concentrate in these three provinces. A comparison of the two figures also indicates that the U.S. and Japanese firms collaborate at the locations geographically close to the distributions of firms with FDI and patents.

We then mapped the data set to the China territory by province (GIS map copyrighted by Harvard Yenching Institution) to Figures 4, 5, 6 and 7. In Figure 7, which shows the distribution of SIPO patents, we find that provinces with higher patent stock are concentrated geographically on the east coast of China, such as Beijing, Tianjin, Jiangsu,

[1] The first patent means the firstly-issued patent, in terms of the issued year, of the selected MNE. We excluded subsequent patents because the location choice of the subsequent collaboration may be affected by the first collaboration (in relation to the first patent) and may not properly reflect the impact of knowledge spillovers (Alcacer & Chung, 2007).

[2] The qualified data mean that the patent must be assigned to a non-China (Japan or USA) enterprise, and the address of the Chinese inventor must be located within one of the 31 political divisions (we excluded Hong Kong, Macau, Taiwan, for historical reasons). Some entries with suspicious input error are deleted as well.

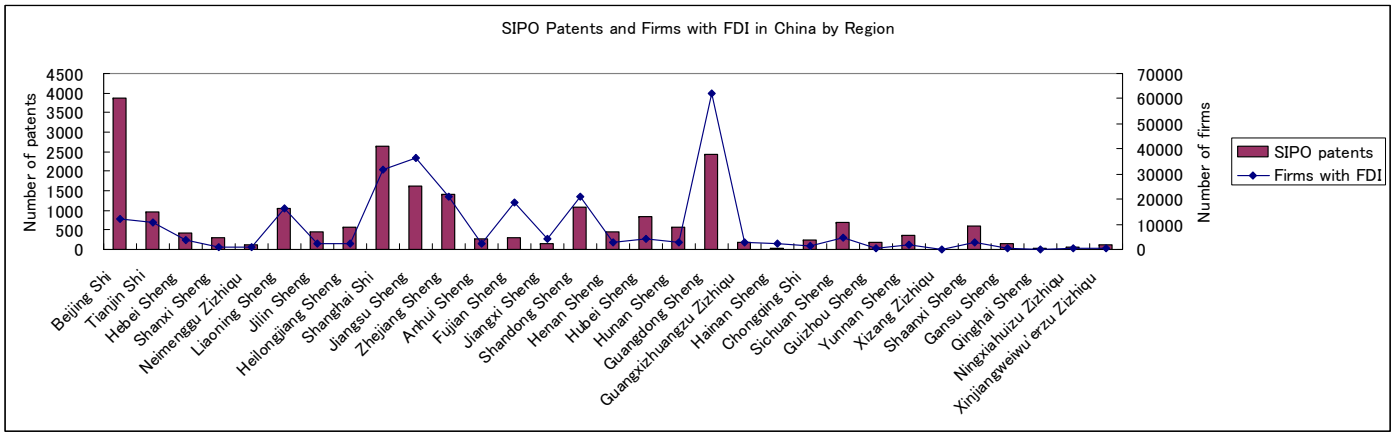

Figure 3. SIPO patents and firms with FDI in China by region(Data source : China Statistical Yearbook 2006)

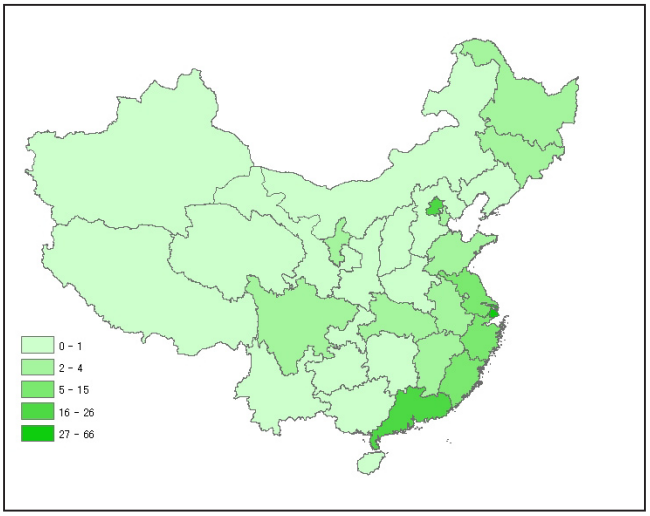

Figure 4. U. S. MNEs collaborate in China(USPTO)

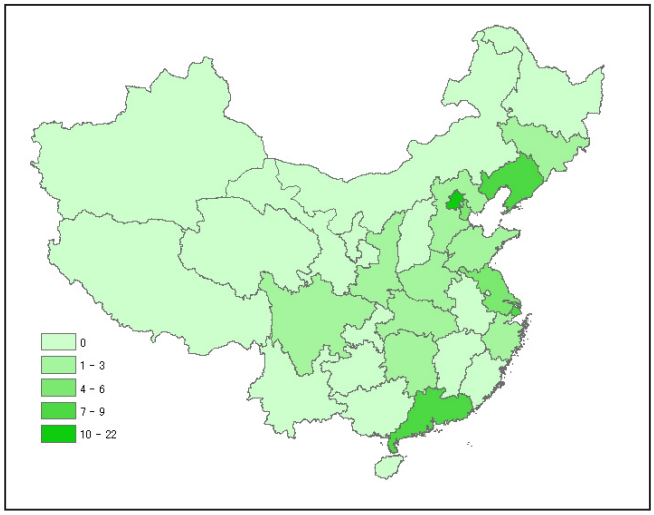

Figure 5. Japanese MNEs collaborate in China(USPTO)

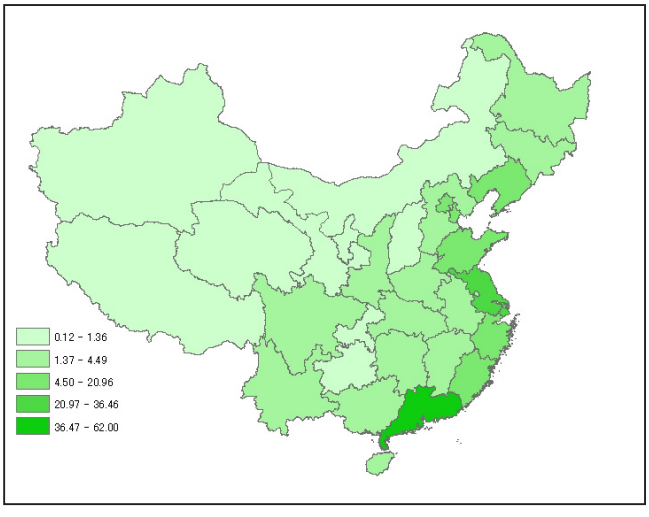

Figure 6. Firms founded with FDI in China 2006

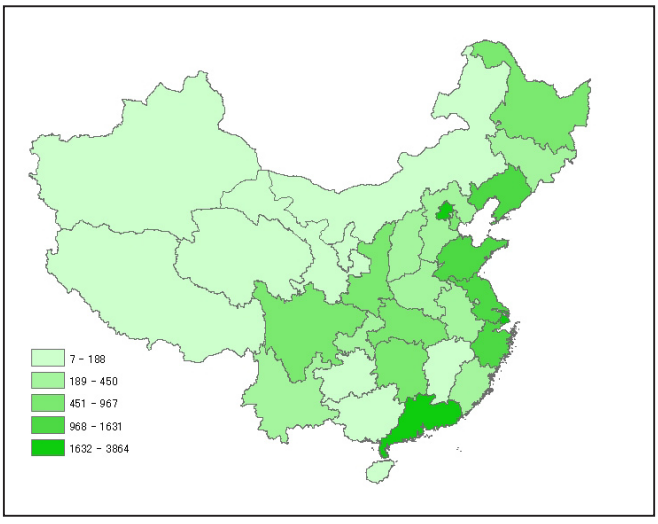

Figure 7. SIPO patents in China 2006

Shanghai, Zhejiang, and Guangdong. Additionally, firms with FDI (Figure 6) are also located intensively on the east coast of China, and the distribution of patent stock is concentrated there as well (Figure 7).

4.2 Correlation of MNEs' collaboration destination and location attributes

By checking the heterogeneity of collaboration locations, we calculated the Herfindahl-Hirshman index (HHI), as shown in Table 1. The Japanese firms have a lower HHI (0.163) than the U.S. firms (0.192). Namely, the Japanese MNEs perform dispersed collaboration a bit more widely than the U.S. MNEs (1/HHI: 6 > 5). The U.S. MNEs' collaboration concentrates more in specific provinces, such as Beijing, Shanghai, and Guangdong.

We further calculate the correlation coefficients of the number of collaborating researchers on FDI firms and patents on the data set shown as Table 2. The results indicate that the Japanese MNEs perform R&D collaboration closer to Chinese patent-intensive provinces than the U.S. MNEs do (0.922 > 0.758). However, the U.S. MNEs perform closer to the FDI-intensive provinces than the Japanese MNEs do (0.647 > 0.490).

4.3 Conditional logit estimation on location choices

To further understand the relationships among knowledge spillovers, FDI, and patents, and to reflect location attributes properly as they relate to the corresponding year of each research collaboration, we utilize conditional logit estimation (McFadden, 1974) to analyze location choices of MNEs' collaboration destination (Alcacer & Chung, 2007; Shimizutani & Todo, 2008). The province-level locations are treated as a binary explained variable, while location-specific factors, patents (p_patent) and firms with FDI (p_fdifirms), are treated as explanatory variables. Table 3 shows the results of conditional logit estimation on the U.S. firms, the Japanese firms, and all firms, respectively. The results show that both patent stock and the number of firms with FDI have a positive influence on U.S. and Japanese MNEs' location choices. However, U.S. MNEs put more emphasis on firms with FDI (1.0489 > 1.0417) while Japanese MNEs put more emphasis on patent stock (1.0062 > 1.0026).

5. Conclusion and Suggestions

5.1 Differences of location strategies on R&D collaboration between U.S. and Japanese MNEs

In this paper, we analyzed the U.S. and Japanese MNEs' location choices for research collaboration in view of knowledge spillovers. We conclude that both Japanese and U.S. MNEs proximate to the provinces with higher R&D intensity and FDI intensity in China, where MNEs can benefit from inward knowledge spillovers. When R&D intensity is high, MNEs can absorb local knowledge to facilitate adaptation to features of the local environment. When FDI intensity is high, there are predictably more business and entrepreneurial activities, which may provide MNEs

Table 1. List of H-H indices

	US-Firms	JP-Firms	FDI-Firms	Patents
HHI	0.192	0.163	0.105	0.079
1/HHI	5	6	9	13

Table 2. Correlation coefficients

	FDI-Firms	Patents
US-Firms	0.647	0.758
JP-Firms	0.490	0.922

Table 3. Summary of conditional logit regression

	All Firms			U.S.Firms			Japanese Firms		
	b	SD	e^b	b	SD	e^b	b	SD	e^b
p_patent	0.0030852	0.0003194	1.0031	0.0026198	0.0003662	1.0026	0.0061791	0.0009479	1.0062
p_fdifirm	0.0460806	0.0038538	1.0472	0.0477563	0.0042618	1.0489	0.0408109	0.0092631	1.0417
no.of obs	5666			4153			1513		
log likelihood	-538.01995			-392.24451			-138.5334		

*b=raw coefficient ; SD of X=standard deviation of X ; e^b=exp(b)=factor change in odds for unit increase in X ; Significances are less than 1% ; Units are counted in 1 patent and 1000 firms.

with knowledge aimed at technological demands that suit local markets, and with business opportunities that aim toward sustainable profits. However, we further clarify that Japanese MNEs put more emphasis on R&D intensity, seeking R&D resources, while U.S. MNEs put more emphasis on FDI intensity, seeking business opportunities in the market. We consider that higher patent stock in emerging economies also represents more potential cost of outward knowledge spillovers from technologically advanced firms (Chung & Alcacer, 2007). Hence, the empirical results further explain that U.S. MNEs may avoid the cost of outward knowledge spillovers by approaching high FDI-intensive locations, rather than Japanese MNEs approaching high R&D-intensive locations. Even though R&D intensity is as a whole positively associated with location choices, negative outward knowledge spillovers, like employees' movement and IPR infringement, may be embedded simultaneously, so approaching high R&D-intensive locations may also induce unexpected risk or cost.

5.2 Suggestion to Japanese MNEs

The results of empirical analysis reflect different strategic behaviors that determine U.S. and Japanese MNEs' location choices. Although U.S. MNEs and Japanese MNEs both emphasize R&D intensity and FDI intensity, U.S. MNEs are business oriented in their preference for FDI intensity rather than R&D intensity. U.S. MNEs perceive the potential cost induced by outward knowledge spillovers in an R&D-intensive location. While Japanese MNEs may put more emphasis in search of R&D resources suitable for themselves, such as researchers with Japanese proficiency (Seki, 2007), we suggest that Japanese MNEs consider the non-negligible cost of outward knowledge spillovers induced in R&D-intensive locations, especially in emerging economies, which may need more improvement of MNE-friendly infrastructures.

5.3 Limitations and future topics

Although the arguments of this research assume the existence of knowledge spillover and its potential to affect location choice in MNEs, the mechanism of location-level characteristics to affect location-selection behavior is not an obvious fact. Besides knowledge spillovers, recent research revealed the existence of various institutional factors that affect MNEs' location choice, such as market size (Basile et al., 2008; Disdier & Mayer, 2004; Dunning, 1998; Ekholm & Hakkala, 2007; Flores & Aguilera, 2007; Hegde & Hicks, 2008; Kumar, 2001; Shimizutani & Todo, 2008), labor availability (Dunning, 1998; Marshall, 1920) and wages (Basile et al., 2008; Dunning, 1998; Flores & Aguilera, 2007; Kumar, 2001; Shimizutani & Todo, 2008), level of knowledge (Dunning, 1998; Hegde & Hicks, 2008; Shimizutani & Todo, 2008), local policy (Basile et al., 2008; Disdier & Mayer, 2004; Dunning, 1998; Peneder, 2001), and distance between the host country and the local site (Shimizutani & Todo, 2008). We do not deny the possibility of those factors to contribute to location choice in a knowledge-intensive industry; knowledge spillover is considered as the essential factor in MNEs' R&D activities (Alcacer & Chung, 2007; Chung & Alcacer, 2002; Ekholm & Hakkala, 2007; Marshall, 1920; Peneder, 2001). After proving the possible effect of knowledge spillovers to location choice of MNEs, as described in this research, this investigation should be further studied to compare the effect of knowledge spillover and other factors. We also suggest adding firm-level variables in order to observe the corporate behaviors of various types of MNEs.

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