Strategic Management Journal
Strat. Mgmt. J., **27**: 151–168 (2006)
Published online 21 November 2005 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/smj.509

LEADERS, LAGGARDS, AND THE PURSUIT OF FOREIGN KNOWLEDGE

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This paper analyzes how firms in different technological and market share positions use foreign R&D to augment their technological capabilities. Technology transfer issues and absorptive capacity arguments are examined to analyze the different technological capabilities of leading and lagging firms. In addition, a new strategic rationale (in terms of non-dominant market share firms) that has not been considered in prior studies analyzing knowledge-seeking FDI is offered. From a panel dataset which includes information on all foreign R&D investments made by publicly traded Japanese manufacturing firms (from 1974 to 1994), I show that Japanese firms investing in foreign R&D tend to be the non-dominant market share firms, but also the technologically leading firms across fairly diverse industries. By considering both the technological and market share positions of firms, this study reveals important characteristics that influence when firms use foreign R&D as part of a strategy to augment their technological capabilities.

INTRODUCTION

Foreign R&D provides a process through which MNEs can increase their stock of knowledge and capabilities from foreign markets (Bartlett and Ghoshal, 1989). Through internal technology transfers, innovative corporations generate a stream of proprietary advantages that can lead to growth in international markets with R&D learned (or acquired) in one market spread throughout other markets (Kogut and Zander, 1993). Over the past decade, a number of studies have focused on firms seeking new knowledge and capabilities through their foreign direct investments (FDI) (see, for example, Cantwell, 1989; Cantwell and Janne, 1999; Chung and Alcacer, 2002; Dunning, 1998; Florida, 1997; Kogut and Chang, 1991; Kuemmerle, 1997, 1999; Wesson, 1993). Many of these studies emphasize the relative technological position of the firm's home country (to the position of the host country of the foreign investment). The results from many of these studies suggest that 'technologically lagging' firms invest in foreign countries to source foreign knowledge (Cantwell and Janne, 1999; Chung and Alcacer, 2002; Kogut and Chang, 1991; Wesson, 1993).

Although the results from these studies tend to suggest that weaker, technologically lagging firms may be trying to reduce their knowledge gap by investing abroad, more firm-specific data and theoretical consideration for the capabilities of these firms are needed before this conclusion can be reached. In this study, I specifically analyze how firms in different positions compared to both their home and global industry competitors use foreign R&D to augment their technological capabilities.

Keywords: knowledge-seeking FDI; technological leaders and laggards; non-dominant firms
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Received 8 April 2003
Final revision received 20 June 2005

In addition, I consider how prior technological capabilities may impact the ability of these firms to pursue and/or benefit from foreign know-how. I question whether theoretical arguments about technology transfer and absorptive capacity would lead to the conclusion that technologically lagging firms have the capabilities to pursue or benefit from foreign R&D. Further, I also use arguments from the literature on strategic interactions among firms (focusing on the position of non-dominant firms in terms of market share) to provide an additional strategic rationale for foreign R&D investment by firms.

Why are these issues important? By more fully analyzing the relative position of firms seeking foreign knowledge, I further our understanding of how foreign knowledge may or may not be useful to both leading and lagging firms. While existing literature tends to assume that weaker technological firms invest in foreign R&D, I show in this paper that it is far more complicated than this. Using richer information on firms, the present analysis shows that firms from Japan investing in foreign R&D tend to be the technologically leading firms compared to both their global and domestic competitors across fairly different industries. This matters because, as I discuss in this paper, technological leaders and laggards are likely to have different abilities to absorb foreign knowledge, and this influences which firms will be able to use foreign R&D as part of a strategy to augment their technological capabilities through foreign investment. Further, existing studies on knowledge-seeking FDI have characterized leader and laggard firms based solely on their R&D intensity. Whether the market share position of firms may influence decisions to invest abroad to acquire knowledge has not yet been considered. The market share results from this paper reveal that Japanese firms investing in foreign R&D tend to be the non-dominant market share firms in their home market. Taking the technology and market share results together, this study reveals important firm characteristics that influence which firms actually pursue foreign knowledge-seeking strategies.

THEORY

Technological laggards

Several studies argue that foreign R&D investments represent a strategy to achieve competitive advantage through generating new technological capabilities and assets (Cantwell, 1989; Dunning and Narula, 1995; Florida, 1997; Kuemmerle, 1997; Mowery, 1997). The basic argument is that technologically lagging firms can augment their knowledge base by locating in leading technological countries to access unique resources and capture externalities created by local institutions and firms. Because technology depends on location-specific factors—such as previous innovations, the education system, and the linkages between educational institutions and firms (Cantwell, 1989)—accessing localized knowledge requires physical proximity. Nelson and Winter (1982), Teece (1986), Kogut and Zander (1992), Almeida (1996), and Almeida and Kogut (1999) (among others) have argued that some knowledge is partially tacit and transfer requires frequent interaction. As a consequence, firms can supplement their existing technologies by investing in foreign countries to access new knowledge (Cantwell, 1989; Wesson, 1993).

Many studies (Patel and Pavitt, 1991; Patel and Vega, 1999; Cantwell and Janne, 1999; Kogut and Chang, 1991, for example) have argued that home country conditions are major determinants of the foreign innovatory activities of large firms. As argued above, differences in the character and national innovation systems (higher education, intellectual property laws, etc.) determine the types of externalities within a location. Nations and industries within nations differ in their attractiveness for investment in R&D. Because of this, extant literature argues that firms from less technologically advanced nations will want to invest in more technologically advanced nations to try to tap into the knowledge that resides there. The approach that has generally been followed has been to compare overall R&D intensity in countries (or industries within countries) and from this, determine whether firms are in a leading (high technological capabilities) or lagging (lower technological capabilities) country. Once a determination has been made about whether the country is a leading or lagging country, all firms within the country are assumed to be the same technological type (see, for example, Kogut and Chang, 1991; Kuemmerle, 1997, 1999; Cantwell and Janne, 1999; Chung and Alcacer, 2002). Generally, the reason this assumption is made is because of limitations in accessing firm-level R&D data for firms outside the United States.

In addition to the problematic assumption that all firms in an industry in a country occupy the same technological position, there are important theoretical issues that remain unresolved in the existing literature on knowledge-seeking FDI. One of the largest issues is that the firms that are technologically weak are assumed to be able to tap into foreign know-how to gain competitive advantage from foreign markets despite their weak positions. However, research on technology transfer (Teece, 1986; Kogut and Zander, 1992, 1993) and absorptive capacity (Cohen and Levinthal, 1990) suggest that technologically lagging firms may not be in the best position to absorb and transfer new knowledge from foreign markets.

Kogut and Zander (1992) discuss technology transfer in terms of knowledge attributes. The main difficulty of technology transfer is concerned with transmitting the tacit component of the technology (Teece, 1986; Nelson and Winter, 1982). The transfer of technology implies the transfer to the recipient of not only the technical knowledge needed to produce products, but also of the capacity to master, develop, and later produce autonomously the technology underlying these products, processes, and know-how. As Nelson and Winter (1982) explain, knowledge often cannot be codified, and even when it can it is not always readily understood by the receiver. Tacit knowledge is extremely difficult to transfer without intimate personal contact, involving teaching, demonstration, and participation. Teece (1977, 1986) has added that with international technology transfer the problems associated with the acceptance of external or 'imported' technology are likely to be accentuated by the need for adaptation of the technology to different conditions, confrontation of large differences in infrastructure between subsidiaries, and distance and communication costs.

Cohen and Levinthal (1990) refer to a firm's ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends as its absorptive capacity. They argue that prior possession of relevant knowledge and skill is what gives rise to creativity, permitting the sorts of associations and linkages that may never have been considered before. Whether technologically weak firms possess the relevant knowledge and skill to be able to assimilate and apply knowledge from foreign markets has not been specifically analyzed, though Barkema, Bell, and Pennings (1996) have found that firms trying to acquire technology in markets outside of the domestic market may lead to a low applicability of an organization's existing experience. It is questionable whether weak technological firms are likely to possess the necessary prior knowledge and skills to be able to simply invest in advanced country locations through foreign R&D labs to augment their existing technological capabilities. Further, studies of international R&D management have found severe difficulties in coordinating offshore R&D subsidiaries (Bartlett and Ghoshal, 1989; Kenney and Florida, 1994).

Perhaps because of these issues, survey results have found that foreign R&D investments are a relatively small component of overall scientific and technological activities of firms (Florida, 1997; Porter, 1990). Firms conduct the majority of their R&D in their home market. Porter and Wayland (1993) note that a full 90 percent of corporate R&D spending by U.S. MNCs takes place in the United States. Further, according to the 1992–93 MITI Benchmark Survey, only 4 percent of Japanese corporate R&D took place abroad. While Japanese firms have internationalized their R&D function later than their European and American competitors and though these percentages have been increasing over the last decade (see Belderbos, 2003, for a review of Japanese overseas R&D), the majority of most firms' R&D is still located in their home country market.

Some recent studies have begun to challenge the view that knowledge-seeking through foreign R&D is done only by firms that want to catch up. Cantwell and Janne (1999) suggest that there are two types of knowledge-seeking behavior. Firms from lagging technical locations may need to catch up and locate labs abroad with an emphasis on improving their existing technology (the conventional view that laggards need to catch up). However, Cantwell and Janne (1999) also suggest that leading technological firms may locate labs abroad to source more diverse knowledge. As they indicate, this can help to explain why knowledge seeking may occur in situations where differences in R&D between nations are small. Chung and Alcacer (2002) also reveal that it may not simply be the technological laggards that seek technology abroad. They find that firms in the semiconductor, electronics, and chemical industries conform to the conventional view of laggards seeking foreign knowledge to catch up, but pharmaceutical firms from technologically leading nations invest in foreign R&D. Neither of these studies focus on whether firms from a country are all of one type (either all leading or all lagging firms), however. More similar to this paper, Penner-Hahn and Shaver (2005), find that Japanese firms with greater pharmaceutical research capabilities patent more drugs and benefit the most from international R&D activities. The focus on pharmaceutical firms needing skills in underlying technology before they can benefit from international R&D and increase their patent output complements the arguments put forth above.

Are technologically lagging firms in the right position to invest in foreign locations to acquire new knowledge? Absorptive capability problems, coordination and technology transfer issues, and questions of capabilities and applicability all suggest that it may be firms that are more technologically advanced that are going to be able to benefit from foreign R&D labs. Similar to existing studies, firms will be analyzed in this study in terms of their relative global technological position to test how leading and lagging firm characteristics impact a firm's decision to pursue foreign R&D. The arguments above also suggest that comparing firms to competitors in their domestic markets would lead to a similar conclusion—that leading technology firms compared to domestic competitors are more likely to have established the necessary prior capabilities to be able to access knowledge that resides in advanced country locations. Therefore, firms will also be considered relative to their domestic competitors to examine how their relative domestic standing impacts the foreign knowledge-seeking strategies they pursue. The absorptive capacity and technology transfer arguments lead to the following hypothesis:

Hypothesis 1: Technologically leading firms are more likely to invest in foreign R&D labs than technologically lagging firms.

Non-dominant firms

Non-dominant firms have been studied in the literature that analyzes strategic actions and reactions by rivals in an industry. Through the study of the competitive interactions among firms, some insight into strategic rationales for non-leader firms to pursue foreign R&D have been offered. However, these arguments have generally been viewed from a market share perspective rather than a technology one. Another important difference is that the knowledge-seeking literature has tended to refer to leader firms as any firm that is above the average in terms of R&D intensity (while a laggard is a firm that is below the average). The non-dominant firm distinction does not use an above- or below-average cut-off to refer to dominant and non-dominant firms. Rather, the dominant firm classification refers to the top firm in the industry in terms of sales. Non-dominant firms that have been analyzed in studies focusing on foreign investment strategies have not been characterized as 'weak' or small firms. Instead, Hennart and Park (1994) have shown that smaller firms may not have enough financial and managerial resources to invest abroad, and therefore the focus has been on medium market share firms in studies that analyze foreign investment strategies. Because the leader/laggard and dominant/non-dominant categories refer to different sets of firms in these literatures, I use the leader/laggard categories when I refer to the technology position of the firm and the dominant/non-dominant categories when I refer to the market share position of the firm.

Non-dominant firms are those firms that are smaller than the largest firms in their industry and that do not have the same advantages or resources for retaliating and damaging challengers. The domestic competitive advantage of leaders may come from a variety of sources, such as lower cost, better products and services, faster innovation, strong distribution channels, or financial strength (Ito and Pucik, 1993). The basic assumption in this literature is that timely strategic actions and reactions are critical for a firm's commercial success. When one firm invests in a new product (or country) market, the competitive advances made by the firm often come at the expense of other firms in the industry.

Porter (1986) hypothesized that successful strategies of non-dominant firms seek to nullify the competitive advantages of a dominant firm, while avoiding the full-scale retaliation. Mascarenhas (1986), Hennart and Park (1994), and Ito (1997) have applied this reasoning to international strategy and argued that non-dominant firms may venture abroad to avoid the retaliation from dominant firms in their home markets, and because they enjoy a relative competitive advantage over foreign firms. Mascarenhas (1986) has shown that in some industries the dominant firm (in terms of market share) has remained domestic while a non-dominant firm has invested abroad to avoid competitive pressures in the home market. Further, Abegglen and Stalk (1985) have documented some Japanese cases where a non-dominant firm entered foreign markets before a dominant firm. For example, Sony entered the United States before Matsushita, Honda entered before Toyota, and Epson entered before NEC.

An important challenge for the non-dominant firms is to develop responses to a dominant firm in the industry that can take away some of this dominant firm's advantage without engaging in head-on collision (Ito, 1997). Investing abroad provides one such response. Mascarenhas (1986) and Hennart and Park (1994) have documented that non-dominant firms invest in FDI ahead of dominant firms, and Ito and Pucik (1993) and Ito (1997) have shown that non-dominant firms export before dominant firms. What has not yet been studied is whether this reasoning applies to firms that seek technology in foreign markets. Similar to investing in new geographic markets, trying to tap into foreign know-how may provide a strategic response for non-dominant firms. Foreign know-how may provide access to new capabilities and technological know-how that can be used to compete with leader firms. Given that non-dominant firms are not the 'weak' firms in the industry, they may in fact be in a better position to transfer and absorb knowledge from foreign markets to be used throughout their multinational network of operations. By investing in foreign R&D, non-dominant firms may be able to compete with dominant firms by accessing new or diverse technology. This strategy could allow non-dominant firms to compete both in their home and foreign markets using this new and/or diverse technological know-how. In sum, non-dominant firm arguments offer a potential strategic rationale for non-dominant firms to pursue foreign knowledge, though this reasoning has not been applied to the literature on foreign knowledge seeking or technological laggards. This reasoning leads to the second hypothesis:

> *Hypothesis 2: Non-dominant market share firms are more likely to invest in foreign R&D labs than dominant market share firms.*

Vestiges of an alternate view can be found in Cantwell and Janne (1999). While these authors focus on the technological position of the firm, their reasoning that leading firms may locate R&D labs abroad to source more diverse knowledge can also be applied to the market share position of firms. Dominant market share firms may realize that to maintain their competitive advantages over the long term they would be better off if they accessed new knowledge in foreign countries before their non-dominant firm competitors. While this is certainly a plausible view, the fact that most firms locate the majority of their R&D investments in their home country suggests that dominant firms have incentives to maintain their focus in their home market to build their technological capabilities. Therefore, the hypothesis offered above focuses on the incentives for non-dominant firms to invest in foreign R&D labs.

DATA AND METHODS

Data

My sample consists of an unbalanced panel of all Japanese publicly traded manufacturing firms over the time period 1974–94. Japanese data sources have been used to construct a database on the financial and foreign knowledge-seeking activities of all Japanese publicly traded manufacturing firms. Wide industry differences appear in the levels of internationalization of R&D. Pharmaceutical drugs and medicines are at the forefront of the globalization of R&D, followed by machinery, electric equipment, and transportation equipment. I limited the sample of manufacturing firms to include all firms in industries in which Japanese manufacturing firms have foreign R&D subsidiaries as of 1994—this includes five industries: chemical (including pharmaceutical), machinery, electric equipment, transportation, and precision instruments. This results in an unbalanced panel of 631 firms (over the time period 1974–94). The sample includes all publicly traded firms in the industries—both domestic and multinational firms. Because these firms are listed on the Tokyo Stock Exchange, they tend to be the larger firms. However, firms can and do enter and leave the sample. After excluding missing values (and after accounting for the 1-year lag described below), I end up with 11,120 firm-year observations.

I collected financial data for each year for each firm over the 21 years of my sample. All financial data come from either the Japan Development Bank (JDB) database (including data on R&D expenditures, Sales (used in the relative market share variables discussed below, and assets)), or the Japan Company Handbook (for age and export data). All financial data have been deflated to the base year 1974 using Bank of Japan deflators.

To determine which firms have foreign R&D labs, a native Japanese speaker consulted the Japanese language directory of firms with foreign subsidiaries, the *Toyo Keizai Shinposha* Directory. This directory lists the main purpose of each firm's foreign subsidiary. For foreign subsidiaries that are R&D labs, the main purposes of these labs are: information gathering, support, or research and development. Because my main interest in this study is on firms that are trying to tap into foreign knowledge, I tried to limit my sample of R&D labs to those that are creating new knowledge in their foreign R&D labs (vs. adapting or exploiting knowledge from their home market). To operationalize this, I limited the types of labs I analyzed to include those subsidiaries whose main purpose was 'information gathering' or 'research and development.'[1] At the end of 1994, out of all publicly traded manufacturing firms in these industries in Japan, 85 firms had 190 foreign subsidiaries with the main purpose of 'information gathering' or 'research and development.' The majority (85%) of the subsidiaries are in the United States, the United Kingdom, or Germany. Of these 190 foreign R&D subsidiaries, 22 were acquired. A native Japanese speaker also consulted the *Toyo Keizai Shinposha* Directory for the years 1989, 1984, and 1980 to ensure that there were no additional foreign R&D subsidiaries that may have been sold or closed (none were found). I also collected foreign investment information (whether a firm has any foreign investment and the number of foreign manufacturing subsidiaries) for each firm from the *Toyo Kaizai* Directory.

Most prior studies that have examined knowledge seeking by firms in foreign markets have used data on FDI into the United States from other OECD nations available from the International Trade Administration (ITA). Kogut and Chang (1991), Hennart and Park (1994), Blonigen (1997), Shaver (1998), and Chung and Alcacer (2002) all use data from the ITA report of 'Foreign Direct Investment in the United States, (various years) Annual Transactions' to construct their dependent variables (or focal independent variables). In addition, most of these prior studies use OECD data on country or industry–country R&D intensities (meaning total R&D expenditures by all firms as a percentage of total sales by all firms) to construct the technological position of all firms (by comparing the country information with average OECD country information). To ensure that there is variation among the industries included in this analysis, I consulted these OECD data to examine the technological position of the industries in Japan.[2] This comparison shows that some of the industries used in this analysis would be characterized as leading, while some would be characterized as lagging. As will be discussed more below, I will also use this OECD classification of industries and R&D intensity data to examine the global technological position of the Japanese manufacturing firms.

I attempted to include private firms in my sample, but unfortunately the limited 3-digit industry and R&D expenditures information prohibited any meaningful analysis.[3] An examination of the names, and sales and overseas labs of these private firms[4] suggests that including these firms would not significantly alter the positions of the publicly traded firms—meaning that in general the private firms are not the leading firms in the industries and they have only invested in a handful of R&D labs in each of the industries under consideration.

Variables

Foreign R&D lab

The dependent variable is a 0/1 variable that takes a value of zero if firm i has no foreign R&D labs at time t, and one if firm i has foreign R&D labs at time t. As will be discussed below, I also ran the results using a dependent variable that takes a value of one if firm i opens a new foreign R&D

[1] Of the R&D labs listed in the *Toyo Kaizai* Directory, the majority of foreign R&D labs were categorized with the main purpose of research and development. Running the analysis with just the research and development category of labs produces very similar results.

[2] I thank Wilbur Chung for providing this OECD data.
[3] I would like to thank Andrew Delios for generously sharing time-series data that were quite time-consuming for him to gather on private Japanese firms for this attempt.
[4] The *Toyo Keizai* Directory contains private firm data on overseas investment.

lab at time t to capture new foreign R&D lab investments by firms.

Independent variables

The Japanese industry classification for all of the technology and market share variables created below is based on industry classifications by MITI,[5] and is available at the 3-digit industry code classification. MITI has adopted the Standard Industry Classification for Japan (JSIC), which is based on the United Nations' International Standard Classification, with some adjustments. By using the MITI data, I was able to develop concordance across the Japanese and OECD industry classifications (with the global technology comparison being forced back up to the 2-digit level, given that that is all that is available on country/industry R&D intensities from the OECD for many industries.) By using the 3-digit MITI data, the concordance of industries is more comparable to prior studies in the knowledge-seeking FDI literature. While the use of 3-digit industry information is an improvement over prior studies that have used the OECD 2-digit industry code classification to determine the relative global standing of firms, accessing less aggregated global industry data would be an interesting area for future research as identifying industry competitors is an important component of the identifying strategic interactions among competitor firms in an industry.

I considered all publicly traded manufacturing firms in the five industries included in the sample to determine a firm's relative position in their industry. By considering quartile categories determined by each 3-digit industry, I am able to control for some differences across these industries, given different levels of expenditures on R&D. Further, using R&D intensity (R&D expenditures/Sales) to create the technology position variables also helps to control for differences across firms simply due to their size.

Global Technology Position variable

To examine the relative technological position of the firms in my sample, I considered two reference groups: global and domestic competitors. (The global technological position variable is more comparable to what has been considered in prior studies.) To determine the relative global technological position of the firms in the sample, I created R&D intensity variables (R&D/sales) for each firm in each year. I then used the OECD average R&D intensity data to create a dummy Global Technology Leader variable that takes a value of 1 if the firm is above the OECD industry average R&D intensity. The industry comparison is either at the 2- or 3-digit industry classification, depending on what is available from the OECD. (For the majority of firms, this comparison is made at the 2-digit level because that is all that is available from the OECD.) I compared the Japanese firms' position in relation to both the OECD average and to an average using just the OECD country–industry data from the United States, the United Kingdom, and Germany (given that this is where the vast majority of R&D labs are located). There are no statistical differences in the results, so I used the OECD average (as this is what most of the prior studies have used). The OECD data are only available starting in the year 1980; therefore, my sample is reduced to the years 1980–94 when I analyze the global technology position of my firms.

I also used the OECD data to specify those industries in which Japanese firms would be categorized as 'laggards' in prior studies that have used the Revealed Technological Advantage (RTA) approach (that of comparing country–industry averages) to classifying firms. According to OECD data, the Japanese industry average R&D intensity is below the average OECD R&D intensity (and also below the average R&D intensity for the United States, the United Kingdom, and Germany) in the following (3-digit equivalent) industries: Drugs and Medicines, Office and Computing Equipment, Radio, TV and Communications Equipments, and Aircraft.[6] Below, I will run these industries separately to specifically examine whether the Japanese firms that have been labeled laggards in prior studies are in fact 'laggard' firms.

Domestic Technology Position variables

To determine the relative domestic technological position of the firms in the sample, I created a

[5] I would like to that Hideki Yamawaki for providing me with the MITI codes and, further, for helping me match the industry codes.

[6] I list aircraft because Japan is below the average on the OECD list; however, in practice there are no Japanese firms that list this industry as their primary industry in the JDB database.

series of dummy variables to reflect the position of the firm in relation to its domestic competitors in its 3-digit industry. Using a domestic comparison, I am able to more thoroughly analyze the relative technological position of the firms, given that I have information on all other publicly traded firms in each of the industries over the entire time period. I used the R&D intensity variable created above to determine the leading R&D intensity firm in each of the 3-digit industries. Domestic Technology Leader is a dummy variable that takes a value of 1 if the firm is the industry leader in the 3-digit industry at time t. I then analyzed the rest of the firms in the industry in quartiles. The variable Domestic Technology 4th Quartile takes a value of 1 if the firm is in the top quartile of firms in terms of R&D intensity in the 3-digit industry (excluding the leader). When I ran the models, neither the 2nd nor 3rd quartile dummy variables were statistically significant; therefore, the excluded category is firms in the 1st, 2nd, and 3rd quartiles.[7]

Domestic Market Share Position variables

To analyze the market share position of the firms in the sample, I proceeded in a similar fashion using total sales of each firm and comparing the domestic position of each firm to its domestic competitors.[8] I first used a firm's total sales to determine the leading market share firm in each of the 3-digit industries. Domestic Sales Leader is a dummy variable that takes a value of 1 if the firm is the industry leader in terms of sales in the 3-digit industry at time t. I then analyzed the rest of the firms in the industry in quartiles. The variable Domestic Sales 4th Quartile takes a value of 1 if the firm is in the top quartile of firms in terms of sales in the 3-digit industry (excluding the leader). Similar to the technological position variables, when I ran the models neither the 2nd nor 3rd quartile dummy variables were statistically significant; therefore, the excluded category is firms in the 1st, 2nd, and 3rd quartiles.

[7] The 3rd quartile firms for both the technology and market share variables were positive, but not significant, when included separately in the models.

[8] While it would be interesting to compare the market share of firms to their global competitors, this is not feasible as country industry sales averages are both not readily available or very meaningful given different market conditions.

Controls

Previous studies of the determinants of foreign R&D have found several firm-level factors to be significant determinants of overseas R&D, including the following.

Exports: Hirshey and Caves (1981) found overseas R&D to have a negative relationship with exports from the parent firm. This has been interpreted as indicating that serving overseas markets through export from the home country makes it more advantageous for the firms to concentrate their R&D in the home country. This control variable is included in the present analysis and is operationalized as the percentage of total sales that are from exports for firm i in year t. Firm-level export data come from the Japan Company Handbook.

Foreign manufacturing subsidiaries: the internationalization of production has been found to be a robust factor that explains the internationalization of R&D across industries (Belderbos, 2001; Odagiri and Yasuda, 1996; Pearce and Singh, 1990). The proportion of overseas production has been found to be positively associated with the propensity of the firm to undertake R&D abroad. With more foreign manufacture and design experience, foreign manufacturing subsidiaries may provide more insider or local knowledge that could foster the role of local technology sourcing (DeMeyer, 1997; Veugelers, 1997; Frost, 2001). This control variable is operationalized as the total number of foreign manufacturing subsidiaries each firm has in each year and is based on the information in the *Toyo Keizai* Directory.

Firm size (assets) has also been identified as an important firm factor. Mansfield and Romeo (1980) found the proportion of overseas R&D to be positively related to firm size. Odagiri and Yasuda (1996) also found firm size to be a significant determinant of overseas R&D and note that a large firm is likely to have richer managerial resources, which could make global R&D activity easier and more attractive. I include a size variable that is operationalized as the total assets of firm i in year t and comes from the Japanese Development Bank Database to control for these issues.

Age of the Japanese firm is included to control for differences between more mature firms and relatively newer firms.

Keiretsu structure of the Japanese system has been identified as providing firms with an important source of competitive advantage (Gerlach, 1992). Horizontal *keiretsu* membership has been argued to offer some Japanese firms with access to financial capital and foreign market information. Horizontal *keiretsu* membership dummies equal one if the firm is affiliated with one of the six main banks in Japan (including Mitsui, Mitsubishi, Sumitomo, DKB, Fuyo, and Sanwa). This affiliation comes from Weinstein and Yafeh's (1995).[9]

Because I perform a firm-level analysis that includes all of the worldwide foreign R&D labs of these firms (my dependent variable takes a value of one if the *firm* has foreign R&D subsidiaries, not if the foreign subsidiary is an R&D lab), I do not include the location attracting variables that have been identified in previous studies. These location-specific variables tend to focus on the technological capabilities and size of the country. For the foreign subsidiaries in this sample, there is not too much location variation among the countries chosen by Japanese firms. The majority (nearly 85%) of the foreign R&D labs of Japanese firms are in the United States, the United Kingdom, or Germany.

Specifications

Because the dependent variable in this study is a dichotomous variable, I use probit analysis in the estimations. I begin by modeling a firm's decision to conduct foreign R&D using the following probit model for panel data:

$$P_{it}(t) = \Phi(\alpha_i + \beta X_{it-1} + \varepsilon_{it})$$

where P_{it} is the probability at time t of a firm conducting foreign R&D; X_{it} is a time-varying vector of covariates or explanatory variables characterizing firm i at time $t-1$, ε_{it} is the unobserved time-constant effects not captured by the independent variables, and Φ is the normal cumulative distribution function. The explanatory variables included in the analysis are the relative technology and market share variables discussed above, and the control variables (including assets, foreign manufacturing subsidiaries, exports, age and *keiretsu* membership). The model accounts for unobserved heterogeneity using a random effects approach. I also ran the same probit specification for panel data (with random effects) on each of the five (2-digit equivalent) industries separately for the domestic comparison to observe whether there are differences across the industries in terms of the technology and market share relative results.[10]

All independent variables are lagged by 1 year. This helps to address the assumption of independence by avoiding contemporaneous correlation. In addition, this addresses the more practical issue that firms make decisions to invest in R&D labs abroad based on information that is available prior to the actual opening of the operation.

Table 1 reports the correlations for the variables used in the analysis. As can be seen in this table, and not too surprisingly, the global technology

[9] A firm is classified as group affiliated with one of the six groups if at least one of the following holds: (1) a group's main bank is the firm's biggest lender for three consecutive years, and total shareholding by members exceeds 20 percent; (2) main bank loans account for at least 40 percent of the firm's loans for at least 3 years; and (3) the firm is historically affiliated with a group.

[10] I do not present the results when breaking down the global technology leader variable by industry, because the results are the same for this variable across the five industries.

Table 1. Correlations

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1.	ForLab	1.0										
2.	DomTL	0.21	1.0									
3.	DomTQ4	0.23	0.11	1.0								
4.	DomSL	0.01	0.14	−0.09	1.0							
5.	DomSQ4	0.22	−0.08	0.23	−0.01	1.0						
6.	GlobTL	0.29	0.12	0.59	0.22	0.17	1.0					
7.	Assets	0.15	0.05	0.07	0.02	0.08	0.02	1.0				
8.	FMSub	0.35	0.13	0.09	0.03	0.11	0.03	0.007	1.0			
9.	Exports	0.11	−0.06	0.01	0.01	−0.01	0.01	0.01	−0.01	1.0		
10.	Age	0.16	0.15	0.11	0.01	0.15	0.16	0.11	0.18	−0.11	1.0	
11.	Keiretsu	0.04	0.01	0.12	0.01	0.17	0.12	0.05	−0.02	−0.06	0.14	1.0

Table 2. Summary of variables

	Variable	Obs.	Mean	S.D.	Min.	Max.
1.	ForLab	11,885	0.1903175	0.6076214	0	19
2.	DomTechLeader	11,865	0.0230447	0.1813515	0	1
3.	DomTech4thQuartile	11,885	0.2341938	0.384365	0	1
4.	DomSalesLeader	11,885	0.0230447	0.1813515	0	1
5.	DomSales4thQuartile	11,865	0.2341938	0.384365	0	1
6.	GlobalTechLeader	8,583	0.2071537	0.4052902	0	1
7.	Assets	11,718	110,742.9	318,733.1	652	6,264,041
8.	ForeignManSub	11,885	1.548536	4.414506	0	98
9.	Exports	11,885	0.1581625	0.1769341	0	0.99
10.	Age	11,885	41.55934	14.64381	0	104
11.	Keiretsu	11,120	0.398705	0.4824755	0	1

Table 3. Variable definitions

Global technology comparison		
Global Technology Leader$_{(t-1)}$	(+)	0/1 dummy variable where 1 = above OECD industry average on R&D/sales expenditures. OECD yearly data (1980–94) used, 2 (or 3)-digit classifications (where available)
Domestic technology comparisons		
Domestic Technology Leader$_{(t-1)}$	(+)	0/1 dummy where 1 = leader firm in 3-digit industry based on expenditures on R&D/Sales each year. 1-year lagged values
Domestic Technology Fourth Quartile Firm$_{(t-1)}$	(+)	0/1 dummy where 1 = firm in top quartile of 3-digit industry terms of R&D/sales expenditures. 1-year lagged values. Leader firm is excluded from top quartile
Domestic sales comparisons		
Domestic Sales Leader$_{(t-1)}$	(?/NS)	0/1 dummy where 1 = leader firm in 3-digit industry based on expenditures on market share (sales) each year. 1-year lagged values
Domestic Sales Fourth Quartile Firm$_{(t-1)}$	(+)	0/1 dummy where 1 = firm in top quartile of 3-digit industry in terms of market share (sales) each year. 1-year lagged values. Leader firm is excluded from top quartile
Controls		
Foreign Manufacturing Subsidiaries$_{(t-1)}$	(+)	Lagged total number of manufacturing subsidiaries abroad
SIZE(assets)$_{(t-1)}$	(+)	Lagged total assets of the firm
Age$_{(t-1)}$	(+)/(−)	Lagged years since establishment of firm in Japan
Exports/Sales$_{(t-1)}$	(−)	Lagged export/sales ratio
Keiretsu Dummy	(+)	Keiretsu member dummy
Industry Dummies		2-digit industry dummies for Chemical, Electric, Machinery, Transportation, and Precision Instruments

leader (GlobTL) and 4th quartile domestic technology fourth quartile firm variables (DomT4Q) are highly correlated. Further, the technology and market share leader firm variables are not that highly correlated (0.14). This low correlation suggests either that there is a time lag before most firms are able to turn their technological endeavors into profitable products via market share, or that the technologically advanced or focused firms are not the firms that command dominant market share in their home market. Table 2 reports summary statistics for the variables used in the analysis. Finally, Table 3 reports the variable definitions and expected signs for each of the independent variables.

RESULTS

The estimation results from the probit model with random effects are presented in Table 4. The estimated log-likelihood, the number of observa-

Table 4. Predictors of foreign R&D labs

Method: Cross-section time series probit specification with random effects[a]

Dependent variable: (0/1) Foreign R&D Lab$_t$

	1. Controls only	2. Global technology comparison	3. Global 'laggard' industries[b]	4. Domestic comparisons
Global technology comparison				
Global Technology Leaders$_{t-1}$		49*	0.32*	
(Above OECD industry mean)		(4.32)	(3.04)	
Domestic comparisons				
Technology position variables				
Domestic Technology Leaders$_{t-1}$				0.38**
				(2.08)
Domestic Technology Fourth Quartile				0.46*
Firms$_{t-1}$ (without industry leader)				(3.96)
Market share position variables				
Domestic Sales Leader$_{t-1}$				0.01
				(0.85)
Domestic Sales Fourth Quartile				0.35**
Firm$_{t-1}$ (without industry leader)				(2.89)
Controls				
Assets$_{t-1}$	0.017	0.01	0.02	0.01
	(0.96)	(0.82)	(1.34)	(0.92)
Foreign Manufacturing	0.021*	0.02*	0.17*	0.02**
Subsidiaries$_{t-1}$	(2.98)	(2.82)	(3.36)	(2.12)
Exports$_{t-1}$	−0.11	−0.31**	0.26***	−0.49
	(−0.60)	(−1.98)	(1.71)	(−1.43)
Age$_{t-1}$	−0.02***	−0.01***	−0.01***	−0.01***
	(−1.73)	(−1.84)	(−1.78)	(−1.94)
Keiretsu member	−0.09	−0.09	−0.08	−0.11
	(−1.24)	(−1.27)	(−1.10)	(−1.23)
Intercept	0.75	−2.92*	−3.43*	−2.98*
	(1.32)	(−3.23)	(−3.54)	(−4.23)
Industry dummies	Yes[a]	Yes[a]	No	Yes[a]
N	9863	7286	955	9407
χ^2	128.96*	119.55*	21.11*	134.42*
(d.f.)	(9)	(10)	(5)	(13)
Wald test (rho = 0)	45.39*	28.78*	4.41*	25.27*

* $p < 0.01$; ** $p < 0.05$; *** $p < 0.10$ (t-test)
[a] Electric, Machinery, Transportation, and Precision Instruments (Chemicals = 0).
[b] This column includes Japanese firms that are in industries below the average OECD R&D intensity (including the following (3-digit equivalent) industries: Drugs and Medicines, Office and Computing Equipment, Radio, TV and Communications Equipment, and Aircraft). See text for more discussion.

tions and the overall model test statistic (which is a Wald chi-square test) are included in the table. A positive (negative) sign on an explanatory variable's coefficient indicates that higher values of the variable increase (decrease) the likelihood that a firm has a foreign R&D lab. Rho (which is a number between 0 and 1) is an indicator for whether a pooled estimator would be different from the panel data (random effects) estimator and it is consistently significant in each model. Column 1 in this table reports the results for the control variables; column 2 adds the global technology position variable; column 3 reports the results for the global technology position variable in those industries in which all Japanese firms would be considered to be 'laggards' when compared to the OECD average industry expenditures (these industries have below average R&D intensities in Japan and if not using firm-level data would be classified as technological laggards); and column 4 reports the results when considering the domestic technology and market share variables.[11]

[11] Although not shown, this model was also run with each of the technology and market share variables separately. The signs

Hypothesis 1 predicted that technologically leading firms are more likely to invest in foreign R&D labs than technologically lagging firms. As can be seen in Table 4, the results show support for this hypothesis from both a global and domestic comparison. Discussing the global technology comparison first, in columns 2 and 3, the positive and significant Global Technology Leader variable shows that leading Japanese technology firms, compared to their global OECD competitors, are statistically significantly likely to invest in foreign R&D labs.[12] Column 3 shows that even when just considering those firms that would be labeled 'laggards' when using the OECD average intensity comparisons, it is actually leading Japanese firms that are investing in foreign R&D labs. This finding contradicts prior studies that assume that firms investing in foreign R&D labs in weak home country industries are weak or lagging firms—on the contrary, column 3 shows that these Japanese firms are above the OECD average in R&D intensity. Regarding the controls, exporting from Japan tends to have a negative impact on a firm's investing in foreign R&D labs, though this is not the case in those industries in the laggard industries in Japan—in these industries, exports are positive and significant. The switching of signs suggests that perhaps intrafirm exporting of intermediate goods (vs. finished products) may play an important role in these industries.

Regarding the domestic comparison, column 4 (in Table 4) reveals that it is the Domestic Technology Leader and Domestic Technology Fourth Quartile firms that are positively and significantly investing in foreign R&D labs. While the global technology comparison revealed that it is above average technology firms, by analyzing quartile differences, the results in this column show that it tends to be top and leading technology firms in Japan that are likely to invest in foreign R&D labs. Similar to the global technology comparison, the export variable reveals that exporting from Japan tends to have a negative impact on firms investing in foreign R&D labs. The rest of the controls behave mostly as expected, except for the *keiretsu* dummy variable, which is negative (though not significant) in every column in Table 4.

Hypothesis 2 predicted that non-dominant market share firms are more likely to invest in foreign R&D labs than dominant market share firms. The results in column 4 (in Table 4) show that the dominant market share firm (Domestic Sales Leader) is not statistically significantly investing in foreign R&D (though the coefficient is positive). Rather, 4th quartile market share firms (Domestic Sales Fourth Quartile Firms) are significantly investing in foreign R&D labs. These 4th quartile market share firms would be classified as non-dominant firms in the literature on strategic interactions among firms, given that they are not the leader firms in their industries.

To further explore the domestic technology and market share comparisons, Table 5 reports the results from the random effects probit model for each of the five industries separately (while the results presented in this table group the industries at the 2-digit level, the domestic technology and market share comparisons are still made at the 3-digit levels as described above). Each of the independent variables identified in column 4 of Table 4 is included in the model, though only the domestic comparison coefficients are reported (owing to space considerations). The results in Table 5 reveal fairly consistent findings across the Chemical, Electric Equipment and Machinery industries. Leading technology firms (Domestic Technology Leader and Domestic Technology Fourth Quartile firms) and non-dominant market share firms (Domestic Sales Fourth Quartile firms) are statistically significantly likely to invest in foreign R&D in these industries. There are some differences in the Transportation and Precision Instruments industries, however. In the Precision Instruments industry, the dominant market share firm (Domestic Sales Leader) is actually statistically significant and negative. This suggests that market share leaders in this industry tend to focus on the home market of Japan for their R&D activities. In the Transportation industry, the market share leader is positively and statistically significantly likely to invest in foreign R&D labs, in addition to the 4th quartile firms. Unlike the other industries, this shows that both dominant and non-dominant Japanese transportation firms in terms of market share invest in foreign R&D.

and significances of the coefficients do not change when these variables are entered separately.

[12] Both the global and domestic comparisons also hold when considering new yearly R&D lab investment for the dependent variable.

Table 5. Domestic predictors of foreign R&D across industries

Method: Cross-section time series probit with random effects

Relative Technological and Market Share variable results reported only, though full models (with all variables from Table 4 column 2 (except industry dummies) included

	Chemical	Electric Equipment	Machinery	Transportation	Precision Instrument
Dependent variable: ForeignR&DLab$_t$					
Technology position variables					
Domestic Technology Leader$_{t-1}$	0.32***	0.29	1.67*	0.39*	1.72*
	(1.89)	(1.25)	(4.42)	(3.02)	(2.67)
Domestic Technology Fourth Quartile Firms$_{t-1}$ (without industry leader)	0.69*	0.32***	0.64*	0.24***	0.11
	(2.99)	(1.68)	(2.01)	(1.68)	(1.06)
Market share position variables					
Domestic Sales Leader$_{t-1}$	0.05	0.12	0.32	0.11***	−0.85**
	(0.15)	(0.54)	(0.61)	(1.70)	(−1.97)
Domestic Sales Fourth Quartile Firms$_{t-1}$ (without industry leader)	0.14***	0.21***	0.11***	0.84**	0.15**
	(1.75)	(1.71)	(1.69)	(2.28)	(1.93)
Control variables from Table 4 were included, though not reported					
N	2585	2960	2102	1842	618
χ^2	29.42*	59.94*	58.57*	54.43*	36.34*
(d.f.)	(9)	(9)	(9)	(9)	(9)

* $p < 0.01$; ** $p < 0.05$, *** $p < 0.10$. (t-test)

Robustness checks

I also ran a bivariate probit model used to ensure that potential interdependencies between a firm's decision to invest abroad and its decision to invest in R&D labs were not biasing the results. This specification controls for omitted variables that may affect the ability of a firm to invest in foreign R&D. The results for the global and domestic technology comparisons and the domestic market share comparison (the focus of the hypotheses) were consistent with those reported in Table 4. I also ran two additional specifications to control for firm fixed effects: a logit specification with firm fixed effects and a simple probit specification with firm dummies included. In both instances the results for the main technology and market share variables are very similar to those reported in Table 4.[13] Further, I ran the models using a negative binomial and zero inflated negative binomial to ensure the results were not dependent on methodological assumptions. Again, the results are very similar to those reported in Table 4.[14] Finally, I also ran the models with the insignificant variables omitted. With the omitted non-significant variables, the results for the technology and market share variables are of the same sign and significance as those reported in Table 4.[15]

As a further robustness check, I created two other sets of technology position variables to test the robustness of the results. First, I created the quartile technology positions based on R&D expenditures rather than R&D intensity. Whether I use the R&D expenditure or R&D intensity to create the technology position variables, the results

[13] In both the fixed effect logit and the probit with individual firm dummies specifications, the sample can include only those firms that change their foreign R&D status—this eliminates all firms that are domestic only in the analysis. The results for each of these specifications reveal very similar statistical significance for most of the variables of interest (except that the fourth quartile market share variable is significant and positive at the 0.10 level (vs. the 0.01 level in Table 4)). The other main difference is that one of the control variables—exports—is no longer significant (though it is still negative). Age and *keiretsu* are dropped from the analysis when using firm fixed effects because these are accounted for in the firm fixed effect. These supplemental results are available from the author upon request.

[14] The only difference from the results reported in Table 4 is that exports are no longer significant in both the negative binomial and the zero inflated negative binomial. The technology and market share variables that are used to test the hypotheses have the same sign and significance. These supplemental results are available from the author upon request.

[15] When the non-significant variables are omitted, the global technology comparison variables have slightly lower standard errors (and higher resulting t-tests)—though they are still significant at the 0.01 level. The other minor changes to the results are that age is no longer significant in the global laggard industry comparison while exports are no longer significant in the domestic comparison model (though both are signed in the same way). These results are available from the author upon request.

reveal that above-average R&D expenditure or R&D intensity firms tend to invest in foreign R&D labs across all specifications. The major difference is that in some of the specifications, while the top R&D intensity firm (the leader in the industry) is significant when using the R&D intensity position variables (as shown in Table 4), the top R&D expenditure firm is not always significant (though it is positive). I don't find this difference to be too surprising because the data show that different firms end up in the top industry position depending on whether R&D expenditure or R&D intensity is used. The important conclusion, however, is that in both cases it is leading Japanese firms that are likely to invest in foreign R&D labs.

Further, I also created the quartile technology positions using an R&D stock variable (created by accumulating R&D expenditures over time and depreciating annual expenditures at a 15 percent rate following Hall, Jaffe, and Trajtenberg, 2000). To create these quartile variables, I used the R&D stock of each firm to calculate the R&D stock intensity (R&D Stock/sales) of each firm in each year. From these data, I recreated my domestic relative technology position variables. I am plagued by missing variables in the early 1970s. Because I do not trust the relative positions of the firms when missing data are such a problem, I ran my sample for the time period 1980–94. The results are similar to those reported in Tables 4 and 5. When comparing the R&D stock intensity variable with the R&D intensity variable, it is not surprising that the results are the same as this change does not significantly alter firm positions relative to their competitors in the industry. The one difference is that industry leader firms sometimes take longer to lose their leading position in the industry. However, given that both the leader firm and 4th quartile firms are significantly investing in foreign R&D labs, this difference does not alter the results.

Finally, I ran two other subsets of my data to test for the robustness of the results. First, I ran my models using a cross-section of individual years instead of the entire panel to control for differences across time. My results consistently hold for each year in the 1980s and the 1990s. In the 1970s, the model is not significant in 1974, 1975, or 1976 (probably due to the rather small number of foreign R&D labs for Japanese firms in these years). However, the results hold for the other individual years in the 1970s. Second, I ran my model including only foreign R&D labs established in the United States, the United Kingdom, and Germany to control for potential differences across locations when including all locations and to be more comparable to prior studies. My results remain very similar to those reported in Tables 4 and 5.

DISCUSSION AND IMPLICATIONS

Prior studies that have examined knowledge-seeking FDI have concluded that technological laggards, or relatively weak firms, are attempting to tap into foreign markets to source foreign knowledge. Because of data limitations, these studies have generally assumed that all firms from one country occupy the same technological position. Further, these studies have not generally considered how difficult a strategy this may be for technologically weak firms. In this paper, I have analyzed how firms in different positions in their home industries use foreign R&D to augment their technological capabilities. By considering the different capabilities of leading and lagging firms, I have offered insight into the abilities of these types of firms to absorb foreign technological know-how. Further, by considering non-dominant market share firms, I have offered a new strategic rationale for why non-dominant market share firms may pursue knowledge-seeking FDI.

By allowing for heterogeneous firms, the present analysis reveals that for Japanese firms investing in foreign R&D, it is the leading technological firms that are investing in foreign R&D across the Chemical, Machinery, Electrical Equipment, Transportation, and Precision Instruments industries. This finding holds across fairly diverse industries—industries that would provide both leading and lagging industries with the United States and other nations if compared on a country or industry level. This finding also holds when Japanese firms are compared to their home country competitors. Finally, this finding holds whether a firm's R&D intensity, R&D expenditure, or R&D stock is used to determine the relative industry position of firms.

The results about which technology firms tend to invest in foreign R&D are important because they confirm that firms have different abilities to absorb and transfer foreign knowledge, and that this influences which firms will be able to use foreign R&D as part of a strategy to augment their technological capabilities through foreign investment. Contrary to the assumptions in many studies on knowledge-seeking FDI, lagging firms are not likely to be able to simply invest in a foreign country to build their technological capabilities. Rather, a firm's prior possession of relevant knowledge and skill is crucial for this type of strategy to work. This suggests that managers need to ensure that their firms have the right knowledge management capabilities for technology absorption and transfer before this type of strategy will be successful.

In terms of market share, the results show that there are some differences across the five industries. For the Chemical, Electric Equipment, Machinery and Precision Instruments industries, non-dominant market share firms tend to invest in foreign R&D. This suggests that non-dominant market share firms view foreign R&D as one route to compete with dominant market share firms in these industries. Accessing foreign knowledge may provide these firms with technological know-how that could be used in both home and foreign markets. As Ito (1997) suggests, this may take away some of the dominant firm's advantage without engaging in head-on collision.

The market share results are different for the firms in the Transportation industry. In this industry, both dominant and non-dominant firms tend to invest in foreign R&D. Looking at the OECD industry-level data shows that this industry is a leading global industry in Japan (meaning that the Japanese average R&D intensity is above both the OECD average and the U.S., U.K., and German average R&D intensity). The first thing this suggests is that other national firms might benefit from investing in R&D labs in Japan. The second thing this suggests is that dominant firms in this industry in Japan may be practicing what Cantwell and Janne (1999) describe as leaders sourcing diverse knowledge. What this implies is that dominant market share firms in this industry may use foreign R&D to access ideas and skills from other advanced markets to continually scan for new ideas to remain competitive in this industry.

Considering the technological and market share results together, this study suggests that it is not the weak technological firms that are seeking foreign knowledge to compete with their industry leaders; rather it is the technologically strong firms in their industry that don't tend to be the dominant firms in terms of market share in their home country that are investing in foreign R&D. Given that these firms tend to be technologically leading firms, non-dominant market share firms may in fact be fairly well positioned to benefit from foreign R&D. By considering both market share and technological position, this study has revealed important firm characteristics that may be needed for firms attempting to pursue a foreign knowledge-seeking strategy.

Two findings from this study deserve further comment. First, the results in this analysis suggest that the horizontal group affiliation in Japan does not always have a significant positive effect (in fact, looking at Table 4, the *keiretsu* dummy variable generally has a negative (though not usually significant) impact on foreign R&D lab investment. Though many studies have suggested that *keiretsu* membership affords firms better information and financing, perhaps the competing effects of horizontal *keiretsu* membership may be causing differences across firms. Hoshi, Kashyap, and Scharfstein (1991) have noted that *keiretsu* firms are less liquidity constrained, and Tan and Vertinsky (1996) have found that *keiretsu* firms have better information through networks for foreign entry decisions. However, *keiretsu* firms also tend to over-invest and over-produce relative to independent firms (Weinstein and Yafeh, 1995).[16] The results from this study suggest that though standard in the literature, perhaps a dummy variable isn't sufficient to truly analyze the effects from this control.

Second, attempts were made to include private firms in the analysis. Unfortunately there is no source that provides R&D expenditures for private firms. While I was able to gather sales, foreign subsidiary activity, and foreign R&D activity to ensure that private firms are not the leading sales or foreign knowledge-seeking firms in these industries, the lack of R&D data prohibits the inclusion of these firms in the models. This limits the generalizability of the findings to publicly traded firms only.

An extension of the research in this analysis would be to consider how different entry mode strategies may be used by firms in different technological and market share positions to pursue foreign knowledge. Belderbos (2003) and Kogut and Chang (1991) have shown that there are differences across entry modes for Japanese parent firms

[16] I thank Mariko Sakakibara for offering this insight into Japanese firms and their membership in *keiretsus*.

with strong or weak R&D intensities at home. Theoretical consideration for the benefits and costs the various entry modes offer firms in different technological positions trying to pursue foreign knowledge would be needed. In addition, specific consideration for how the capabilities of technologically leading and lagging firms would influence the abilities of these firms to benefit from different entry mode strategies would be needed.

Future research may also benefit from focusing more on analyzing strategic actions and reactions of firms competing in global industries. Bartlett and Ghoshal (1989) argue that firms competing in global industries need to adopt a global approach to innovation. They suggest that the intensity of competition between firms requires an integrated strategy for global innovation; basic and/or applied research needs to be carried out throughout an MNE's network in order to formulate new product concepts that are responsive to the demand characteristics of the major markets. The results in this study suggest that technological leaders are pursuing foreign knowledge—not technological laggards. This implies that international rivalry among technologically strong firms from different countries may be driving more of the knowledge-seeking foreign investments than is commonly assumed. Future studies that analyze more extensively who a firm's main competitors are would further enhance our understanding of some of the issues considered in this paper.

Finally, there are limitations to this study. One limitation is that the results may only apply to Japanese firms. Prior studies have noted that Japanese firms are latecomers to both international expansion and foreign R&D (see Belderbos, 2003, for a discussion of this issue). While the theoretical arguments about the differences between technologically leading and lagging firms and dominant and non-dominant market share firms should apply to all firms without regard to their national country of origin, further study of firms from different home nations are clearly needed to determine how broadly the results hold. Although Japanese firms are latecomers to international expansion, the benefit of using the Japanese sample is that there is very rich information that is available on the foreign subsidiary activities of Japanese firms. Further, because Japanese firms are latecomers, the time period of the analysis in this paper captures the initial establishment of all but a handful of Japanese foreign R&D labs. An issue that remains unexplored in this paper is how diversified Japanese manufacturing firms are and how this may impact their ability to tap into foreign knowledge. I followed Japanese Development Bank (JDB) norms and classified firms based on their industry with the largest sales. Examining the extent of a firm's diversification in both related and unrelated industries could provide insight into capabilities development that is not considered here. Finally, this analysis provides an examination of the types of firms that pursue foreign R&D, in terms of the home competitive market. It does not address whether this strategy actually benefits the firms in any way. An additional issue for future research is examining whether these foreign labs have beneficial effects on the technological capabilities of the firms that invest in them.

ACKNOWLEDGEMENTS

I would like to thank Wilbur Chung, Mauro Guillen, Vit Henisz, participants in the Jones Center brown bag seminar series at Wharton, Associate Editor Will Mitchell, and two anonymous referees for helpful comments. I would also like to thank Misaki Hidaki, Emi Morita, Hidefumi Takeuchi, and Miho Ushijima for research assistance. I am indebted to Wilbur Chung, Andrew Delios, and Hideki Yamawaki for generously sharing data. Finally, financial support from the Reginald H. Jones Center for Management Policy, Strategy and Organization, The Wharton School, University of Pennsylvania is gratefully acknowledged.

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