2010-E-1

R&D Spillovers and Foreign Market Entry: Acquisition vs. Greenfield Investment

Kazuhiko Yokota*
Kun-Ming Chen**

The authors would like to thank Joshua Little and David Kritzberg for their helpful comments and suggestions for the earlier draft. All errors are ours.

* Corresponding author, School of Commerce, Waseda University, 1-6-1, Nishiwaseda, Shinjuku, Tokyo, 169-8050, Japan. Tel.: +81-3-3204-8994, E-mail: yokota21@gmail.com.

** Department of International Business, National Chengchi University, NO. 64, Sec. 2, Zhi Nan Rd., Wenshan District, Taipei City 11605, Taipei, Taiwan. Tel.: +886-2-2938-7515, Fax: +886-2-2938-7699, E-mail: kchen@nccu.edu.tw

Abstract

This paper presents a three-stage game to model the entry behavior of a multinational firm in the presence of R&D spillovers. The multinational firm's entry mode choice – that is, to invest to set up a new plant or merge with a local firm – is a function of the magnitude of spillovers, as well as the relative cost of greenfield investment, and mergers and acquisitions. It is also shown that the size of social welfare of the host country depends on the degree of R&D spillovers. These model results produce strong implications for antitrust policy, particularly for developing countries.

Keywords**:** Foreign direct investment, R&D spillover, Merger and acquisitions, Greenfield investment,

JEL Classification**: F21, O32, L10**

1. Introduction

Technology sourcing and technology transfer have become two important subjects, not only for academics, but also for firms of developed, as well as developing, countries. Foreign direct investment (FDI) is one of the primary channels for transferring technology across borders. Developing countries have been trying to attract foreign firms with high research and development (R&D) intensity from developed countries as means of benefiting from technology sourcing and R&D transfer. In particular, the importance of overseas R&D spillovers for economic growth has been recognized since Coe and Helpman (1995), and Coe, Helpman, and Hoffmaister (1997). Much empirical work has provided evidence of the benefit from R&D or technology transfer across borders through total FDI.[1]

FDI can typically be broken into two components: greenfield investment, and cross-border mergers and acquisitions (M&A). Although there are many papers that examine the effects of total FDI on host firms' productivity, the relationship between the various channels of technology transfer and the firm's performance in host countries has received little attention. This sounds strange because not only greenfield FDI but also cross-border M&A have become the preferred mode of overseas investment by multinational companies, for both the bulk of foreign FDI in developed countries and for increasing shares in the developing countries.

There have been relatively few empirical studies focusing on the relationship between the choice of entry mode and R&D spillovers.[2] The paper by Liu and Zou (2008) is, as far as we are concerned, an exception. With Chinese high-tech industry data, they examine differences in the impact of greenfield FDI and M&A on the innovation performance in a single framework and show that technology spillovers are generated through the R&D activities of foreign firms, and

[1] See Yokota and Tomohara (2010) and Keller and Yeaple (2009) for recent survey of empirical studies.
[2] There are some empirical studies on the impact of (only) M&A on performances of acquired firms. See Bertrand and Zunig (2006), Porrini (2004), and Ruckman (2005). See also Shimizu, et al. (2004) and Cloodt, et al. (2006) for a recent survey.

that M&A activities positively influence the innovation performance of local firms. Studying the difference in effects of entry modes on economic growth, instead of R&D, Wang and Wong (2009) show that greenfield FDI and M&A could have different growth impacts in host countries. They suggest that greenfield FDI positively affects economic growth, while M&A affects economic growth only if the host country contains relatively large human capital. These two recent empirical works suggest that we should separate FDI into greenfield and M&A investments when we examine the channels of R&D spillovers and the impact of FDI on economic growth.[3]

Similar to the empirical literature, the theoretical literature has produced only a few papers up to the present: the interaction between technological innovation and firm entry mode choice has been a neglected issue. Buckley and Casson (1998) provide a general framework for an integrated analysis of the foreign market entry decisions, encompassing the choice between export, licensing, joint venturing, and whole-owned foreign investment. They don't, however, consider any spillover effects. Petit and Sanna-Randaccio (2000) develop a game-theoretical model to examine the impact of a firm's mode of foreign entry on the incentive to innovate, as well as the effects of R&D activities and technological spillovers on the firm's international strategy. Their results indicate that there is a positive relationship between multinational expansion and R&D investment, but they do not consider the firm's choice between M&A and greenfield investment. Although there are many other papers of mode-choice between M&A and Greenfield investments, such as Gorg (2000), Hijzena et al. (2008), Nock and Yeaple (2007), Kim (2009), and Raff et al. (2009), none of these studies focus on the possible interaction between a firm's R&D activities and its choice of entry mode.

[3] In his brief note, Lall (2002) notices that firms with lower R&D intensity are more likely to buy technological capabilities abroad by acquisition, while those with strong technological advantages are likely to set up greenfield ventures.

In this paper, we build a model combining key aspects in the models of Petit and Sanna-Randaccio (2000) and others to construct one theoretical framework that allows for two entry modes with R&D spillovers. Within this framework, we can examine the interaction between a firm's R&D decision and its foreign entry mode choice, including the choice between greenfield investment and M&A. A three-stage game-theoretical model is developed. In the first stage, a firm, which considers entering a foreign market, chooses its R&D level and makes an offer of M&A to one of the local firms in the host country. In the second stage, the local firm decides whether to accept or reject the offer. If the local firm rejects the M&A offer, then in the third stage, the foreign firm chooses one of the other two options, i.e., green-field investment or staying out of the market.[4] In the model we allow for imperfect appropriability (i.e., technological spillover between firms). It is shown that the extent of technological spillover is an important determinant in the firm's choice of entry modes. The welfare implications of alternative entry modes to a host country are also discussed.

The rest of this paper proceeds as follows. Section 2 presents the model and examines the effects of R&D activities and technological spillovers on the foreign firm's international expansion strategy. Section 3 investigates the welfare effects of different entry modes of a foreign entrant firm on a host country. Brief concluding remarks are given in the final section.

2. A Model of R&D Expenditures with Spillovers and Foreign Market Entry

To analyze the effects of R&D investment with spillovers on the mode of foreign market entry, we set up a three-stage game-theoretical model. Suppose that there are three firms: one foreign firm and two local firms. The products of the firms are homogenous.

In the first stage the foreign firm chooses its level of R&D investment and at the same time

[4] In Appendix A, we discuss a possible extension to include a third option for the entrant firm: the export option.

makes an offer of M&A to one of the local firms. In the second stage, after observing the choice of R&D level of the foreign firm, if the local firm accepts the offer, then the foreign firm along with the acquired local firm competes against the other local firm in the local market and the game ends. If both local firms reject the offer, then in the third stage the foreign firm chooses either to enter the market by greenfield investment or to stay out of the market.

It is assumed that the acquired local firm obtains the reservation profit, F, which is at least equal to or more than the profit it could get if it did not accept the offer. A strategy for the foreign firm prescribes a choice of the level of R&D, r, for the first stage where the strategy space is infinite and there is a choice of two possible actions at the second information set, i.e., (greenfield investment, stay out) where the strategy space is finite. If the foreign firm chooses greenfield investment, then the foreign firm competes against two local firms in the Cournot oligopoly fashion. If the foreign firm decides not to enter the market, then it gets zero profit and two local firms compete in the Cournot duopoly market. Assume only local firm 1 has an option to accept or reject the offer of M&A by the foreign firm.

To simplify, we assume that only the foreign firm invests in R&D. We consider the process innovations, which can reduce the marginal cost of the investing firm. We also assume that two local firms enjoy the spillover effects from the foreign firm's R&D investment by a certain proportion. The foreign firm chooses the level of R&D investment so as to maximize its profit in the first stage while the two local firms can benefit from the foreign firm's R&D. It turns out that the foreign firm faces a dilemma: the direct effect of R&D expenditures can increase its profit and its indirect effect might reduce its profit by raising competitors' productivities. This situation is pervasive in the real world, especially for the case of foreign direct investment in developing host countries by firms from developed countries.

Define $\pi_{i*}, \pi_{i1}, \pi_{i2}$ as the profit functions of the foreign firm and two local firms, respectively, where $i=A,G,N$. Let A and G denote M&A and greenfield investment, respectively, and N represents the staying out strategy. An asterisk stands for the functions or variables for the foreign firm and subscripts 1 and 2 refer to the two local firms. Assume that all firms are forward-looking. Thus, a sub-game perfect Nash equilibrium (SPNE) is adopted as a solution concept.

The foreign firm has a marginal cost, c_m, and the two local firms have the same marginal cost, c_d. If the foreign firm enters the local market with an M&A strategy, then it must pay the reservation profit, F, to the acquired local firm. Thus, the profit of the foreign firm is $\pi_A^* = \max_{q^*}\left[(p-c_m)q^* - F\right]$ and the profit of the acquired local firm (π_{A1}) equals F. The profit of the other local firm is $\pi_{A2} = \max_{q_2}\left[(p-c_d)q_2\right]$.

In the case of greenfield investment, the profit function of the foreign firm is $\pi_G^* = \max_{q^*}\left[(p-c_m)q^* - K\right]$, where K shows the fixed costs for greenfield investment including the purchase price of land, the building cost of the plant, the set-up cost of machinery, and so on. Without any loss of generality, we assume that K is greater than F, and further assume that $F=\gamma K$, where $\gamma \in (0,1]$. This means that the greenfield strategy is more costly than M&A. The profit function of the two identical local firms is now $\pi_{Ai} = \max_{q_i}\left[(p-c_d)q_i\right]$, i=1,2.

Let r denote a level of R&D investment. Marginal cost c_m is a decreasing function of r, $c_m(r)$, where $c_m^{'}<0$. We assume that the foreign firm's R&D investment has a positive spillover effect on the local firms' cost structures, $c_{di}(r)$, i=1, 2, and $c_{di}^{'} = \beta, \beta \in [0,1]$. If β is zero, then no spillover effects occur. Since $0 \le \beta \le 1$, thus we have $c_m \le c_d$.

Consider a linear market demand function. Suppose that the inverse demand function

is $p = \alpha - Q$, where Q is the sum of all three firms' outputs, q^*, q_1 and q_2, and α is a constant which is large enough so that the equilibrium price is strictly positive. We also assume that the cost functions can be written as follows;

$$c_m(r) = c - r \quad , \tag{1}$$

$$c_d(r) = c - \beta r \, , \tag{2}$$

where c is a constant.[5] We assume that the total cost of R&D investment is a quadratic function of r, which implies that R&D activity is characterized with decreasing returns to scale.

This model is solved through backward induction. In the third stage the foreign firm chooses greenfield investment or to stay out of the market. In this stage, equilibrium profits for the three firms can be derived from the first-order conditions.[6] Since the best-response functions are downward sloping in these cases, players' strategies are strategic substitutes. The case in which the foreign firm decides to enter the local market by a greenfield investment strategy can be shown in Figure 1.[7] Figure 1 indicates that an increase in β induces an outward shift of the best-response function of the local firms. As a result, the equilibrium output of the local firms expands while the foreign firm's output shrinks.

[5] We analyze only positive spillover effects. Possible negative spillovers, such as pollution and computer viruses, are not considered in this study

[6] The second-order conditions are negative for the foreign and local firms with any strategies, such as greenfield, staying out, and M&A.

[7] $R_d(q_m)$ indicates the aggregate of two local firms' response functions.

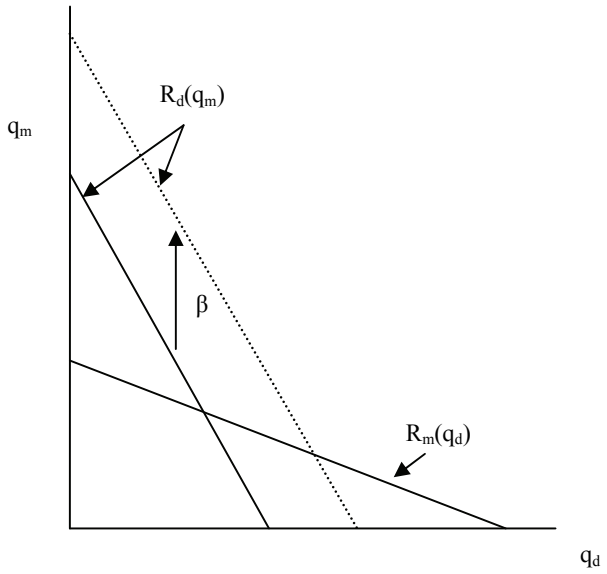

Figure 1. Equilibrium post-entry output levels

Solving the best-response functions, we have equilibrium profits as follows:

$$\pi_G^* = \frac{1}{16}\left(\alpha - 3c_m + 2c_d\right)^2 - K, \tag{3}$$

$$\pi_{G1} = \pi_{G2} = \frac{1}{16}\left(\alpha + c_m - 2c_d\right)^2. \tag{4}$$

If the foreign firm chooses to stay out of the market, then equilibrium profits are:

$$\pi_N^* = 0, \tag{5}$$

$$\pi_{N1} = \pi_{N2} = \frac{1}{9}\left(\alpha - c_d\right)^2. \tag{6}$$

In the second stage, local firms can choose to either accept or reject the offer of M&A. If local firm 1 accepts the offer, then equilibrium profits for the foreign and local firms are: `

$$\pi_A^* = \frac{1}{9}\left(\alpha - 2c_m + c_d\right)^2 - \overline{F}, \tag{7}$$

$$\pi_{A1} \geq F, \tag{8}$$

$$\pi_{A2} = \frac{1}{9}\left(\alpha - 2c_d + c_m\right)^2. \tag{9}$$

Here, F is a reservation profit, $\overline{F} \leq \pi_{Ni}, \; i = 1, 2$.

In the first stage the foreign firm chooses its optimal level of R&D investment which involves the following cost: $\Gamma(r) = r^2$. Substituting equations (1) and (2) into profit functions and solving the profit maximization problem with respect to *r*, we obtain the optimal R&D levels under M&A and greenfield investment strategies, respectively:[8]

$$\tilde{r}_A(\beta) = -\frac{(c-\alpha)(\beta-2)}{-5-4\beta+\beta^2},\ \forall \beta \in [0,1], \tag{10}$$

$$\tilde{r}_G(\beta) = -\frac{(c-\alpha)(2\beta-3)}{-7-12\beta+4\beta^2},\ \forall \beta \in [0,1]\ . \tag{11}$$

Proposition 1: *In the cases of M&A and greenfield investment, the optimal R&D levels are positive and monotonically decreasing functions for any level of technology spillover; that is,* $\tilde{r}_A(\beta)>0,\ \tilde{r}_G(\beta)>0,\ \tilde{r}'_A(\beta)<0,\ \tilde{r}'_G(\beta)<0,\ \forall \beta \in [0,1]$.

Proof: See Appendix B.

The above proposition indicates that the higher the spillover effect is, the lower the optimal R&D expenditures will be. This is due to the fact that a higher spillover effect implies a more serious free-rider problem so that the return on the firm's R&D investment is lower.

We next illustrate the difference in R&D expenditures between greenfield investment and M&A. This is done if we take the corner values of each optimal R&D expenditure when β=0 and β=1. From equations (1) and (2), it is straightforward to obtain the following results:

$$\tilde{r}_A(0) = \frac{2(\alpha-c)}{5},\ \tilde{r}_A(1) = \frac{\alpha-c}{8},$$
$$\tilde{r}_G(0) = \frac{3(\alpha-c)}{7},\ \tilde{r}_G(1) = \frac{\alpha-c}{15}.$$

Clearly, we have $\tilde{r}_A(0) < \tilde{r}_G(0)$ and $\tilde{r}_A(1) > \tilde{r}_G(1)$. Graphically, we have the following relationship of the equilibrium R&D expenditures between M&A and greenfield investment.

[8] Under the "stay out" strategy, foreign firm spends zero R&D efforts and the local firms do not receive any spillover effects.

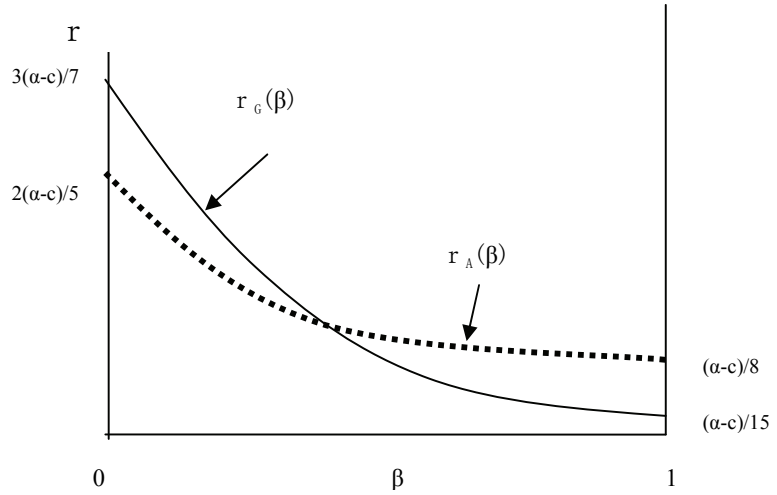

Figure 2. Optimal post-entry R&D expenditures

These results are summarized in the following proposition:

Proposition 2: *If the spillover effect, β, is small, then* $\tilde{r}_A(\beta) < \tilde{r}_G(\beta)$*, that is, R&D investment is greater in greenfield investment than in M&A. If the spillover effect, β, is large, then* $\tilde{r}_A(\beta) > \tilde{r}_G(\beta)$*, that is, R&D investment is greater in M&A than in greenfield investment.*

Proof: See Appendix C.

This proposition provides new insights into the relationship between R&D activity and the entry mode chosen by the multinational firm. It indicates that the post-entry R&D levels under different modes are crucially dependent on the extent of technological spillovers. Its economic intuition is clear. As shown in Figure 2, the absolute value of the slope of $r_G(\beta)$ is larger than that of $r_A(\beta)$, which implies that the free-rider problem is more serious in the case of greenfield investment than M&A. Thus, the firm has less incentive to invest in R&D in the former case. This is simply because there exist two competitors in greenfield investment and one competitor in M&A against the entrant firm in the post-entry market. However, Figure 2 indicates that when technological spillovers are low, the firm (when choosing greenfield investment) is willing to invest more in R&D than when choosing M&A. This is because cost advantages originating

from R&D investment yield a higher payoff when facing two competitors instead of one competitor.

Combining these results with the profit functions, we have the equilibrium profits for each case. Firstly, the equilibrium profits for the greenfield investment strategy are:

$$\pi_G^*(\beta,\gamma)=\frac{16(c-\alpha)^2}{(7-2\beta)^2(1+2\beta)^2}-K, \qquad K=\overline{F}/\gamma, \quad \gamma\in(0,1], \tag{12}$$

$$\pi_{Gi}(\beta)=\frac{(c-\alpha)^2(1+5\beta-2\beta)^2}{(7-2\beta)^2(1+2\beta)^2}, \quad i=1,2. \tag{13}$$

Here, γ represents the share of *F* to *G*. In other words, if γ is larger, then the fixed costs of greenfield investment is smaller relative to those of M&A.

Secondly, if the foreign firm chooses to stay out of the market, then the equilibrium profits for the local firms are:

$$\pi_{Ni}=\frac{1}{9}(c-\alpha)^2, \quad i=1,2. \tag{14}$$

Finally, if the foreign firm chooses M&A, the equilibrium profits for the local firms are:

$$\pi_A^*(\beta)=\frac{9(c-\alpha)^2}{(-5+\beta)^2(1+\beta)^2}-\overline{F}, \tag{15}$$

$$\pi_{A1}=\overline{F}, \tag{16}$$

$$\pi_{A2}(\beta)=\frac{(c-\alpha)^2(-1-3\beta+\beta^2)^2}{(-5+\beta)^2(1+\beta)^2}. \tag{17}$$

Although it is tedious, it is not difficult to show that the foreign firm's equilibrium profit is a decreasing function of β and that local firms' equilibrium profits are increasing functions of β. This is intuitively plausible, because the foreign firm suffers from more profit loss from technology leakage to local firms with a larger β. On the other hand, local firms gain more from the technology spillover when β is larger.

We next examine the relation between the level of R&D expenditures and the entry mode

chosen by the foreign firm. As we discussed earlier, in the third stage of the game the foreign firm has two choices - that is, greenfield investment and staying out. In the third stage the foreign firm compares the profits of the greenfield (π_G*) and staying-out options (π_N*).

First, we demonstrate the relationship between the profit of the greenfield (π_G*) option and the profit of the staying-out (π_N*) strategy, as shown in Figure 3:

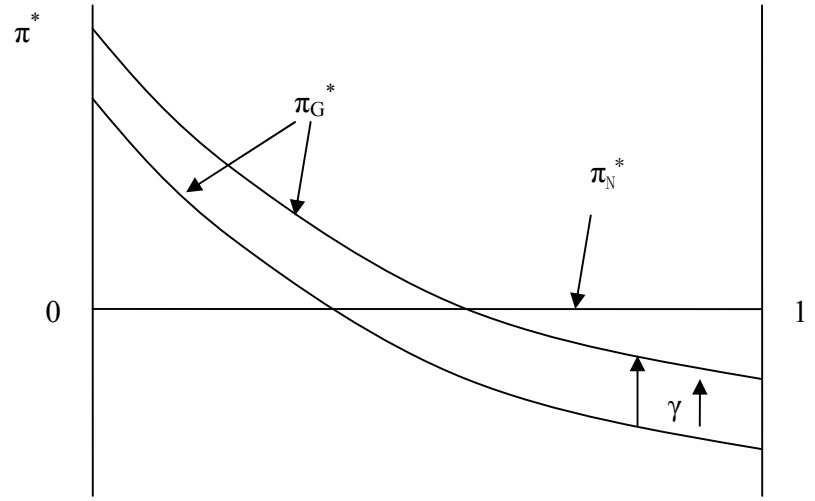

Figure 3. Foreign firm's post-entry profit

Or,

$$\overline{\pi}^* = \begin{cases} \pi_G^*, & if\ 0 \le \beta \le \widetilde{\beta}(\gamma), \\ \pi_N^*, & if\ \ \widetilde{\beta}(\gamma) \le \beta \le 1, \quad \gamma \in (0,1], \end{cases} \tag{18}$$

If γ increases, then the profit curve of the greenfield (π_G*) choice moves upward. Intuitively, since F is a fixed reservation cost, an increase in $\gamma\left(=\overline{F}/K\right)$ indicates a decrease in greenfield investment fixed cost (K). A decrease in greenfield investment fixed cost improves the profitability of the foreign firm.

In the second stage of the game, local firms compare the possible profits from two alternatives: accepting the offer of M&A vs. rejecting the offer and then competing with the

entering firm via greenfield investment, or accepting the offer of M&A vs. rejecting the offer and then competing with the other local firm. This is illustrated in Figure 4.

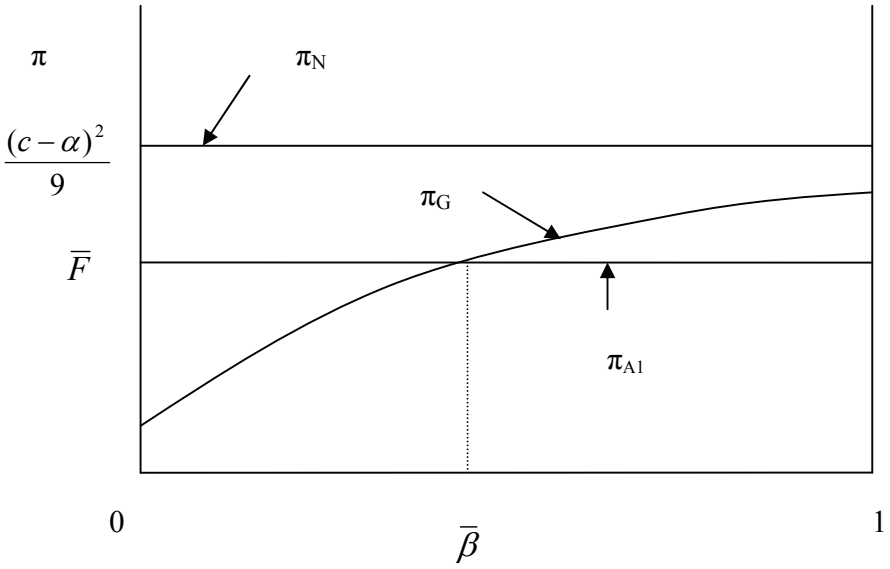

Figure 4. Local firms' profits

Figure 4 shows that the best circumstance for the first local firm is that in which the potential entrant chooses to stay out of the market. When the potential entrant chooses to enter the market, the choice of the local firm between accepting and rejecting the M&A offer depends on the degree of spillovers. If spillovers are small, then the local firm is likely to accept the offer and obtains the reservation profit, whereas if spillovers are large, then the local firm is likely to reject the offer, i.e.:

$$\bar{\pi} = \begin{cases} \pi_A, & if\ 0 \le \beta < \bar{\beta}, \\ \pi_G, & if\ \bar{\beta} \le \beta \le 1. \end{cases} \tag{19}$$

This is due to the fact that an increase in spillovers will increase the profits of the local firms when rejecting the M&A offer. As a result, the firm's reservation price for the M&A offer is higher.

The following propositions summarize one of our main results:

Proposition 3: *In the linear model, there are three SPNEs depending on the degree of β and γ.*

1. *{the foreign firm chooses* $\tilde{r}_A(\beta)$*, the first local firm accepts the offer, the second local firm enters the market},*
2. *{the foreign firm chooses* $\tilde{r}_G(\beta)$*, the first local firm rejects the offer, the foreign firm chooses greenfield investment, the second local firm enters the market}, and*
3. *{the foreign firm makes an offer, the first local firm rejects the offer, the foreign firm chooses staying-out, the second local firm enters the market}.*

Proof: See Appendix D.

This proposition can be drawn graphically as shown in Figure 5.

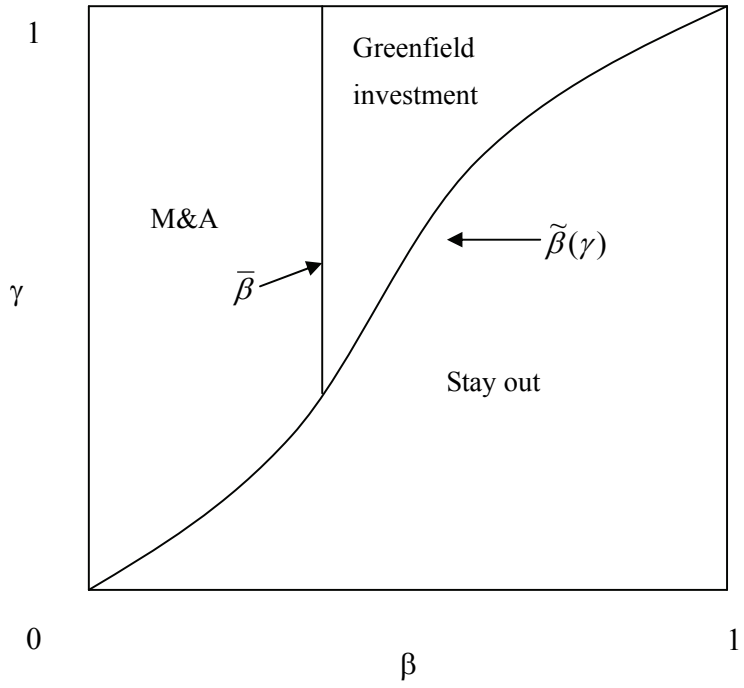

Figure 5. Equilibrium entry modes

Note: There is an infeasible area where γ equals zero since the range of γ is strictly positive by assumption.

Figure 5 illustrates the relationship between the SPNE and two important exogenous variables, γ and β. It clearly reveals that with larger spillover effects (or the free-rider problem is more serious), the foreign firm tends to choose to stay out of the market, unless the entry cost is lower.[9] If the firm chooses to enter the market, then its choice between M&A and greenfield investment depends on the level of technology spillovers and the difference in entry costs between greenfield investment and M&A. If both the spillovers and cost difference are large, then in equilibrium the foreign firm is likely to choose greenfield investment. This is sensible since the local firm is more likely to reject the M&A offer under the case of higher spillover effects, and a larger γ implies a lower entry cost via greenfield investment relative to M&A. On the other hand, if both the spillovers and γ are small, then in equilibrium the foreign firm is likely to choose an M&A strategy to enter the market in the host country.

3. Welfare Analysis

The host country's welfare, W_i, is defined as the sum of its consumer surplus (CS) and the total profits of the local firms:[10]

$$W_i = \int_{Q_i^* \subset Q} \{D(p_j(Q_j)) - p_j(Q_j)\} dQ_j + \sum_{k=1}^{2} \pi_{jk}, \quad j = A, G, N. \tag{20}$$

Since an increase in β indicates an improvement in the profitability of the local firms, total profits of the local firms (second term) increase in β. Since players' output strategies are strategic substitutes as indicated in Figure 1, an increase in β induces an output expansion of the local firm(s) and an output contraction of the foreign firm. Since the direction of output changes in the foreign firm and the local firms are different, a change in equilibrium price is ambiguous a priori.

[9] There is an infeasible area where γ equals zero since the range of γ is strictly positive by assumption.
[10] We assume that the foreign firm remits all profits back to its home country.

Figure 6 provides numerical examples of consumer surplus in M&A, greenfield investment, and staying-out strategies for $\beta \in [0,1]$ when α=1, c=1/10, γ=2/3, and $\overline{F} = \frac{\pi_{N1}}{2} = \frac{1}{18}(c-\alpha)^2$.

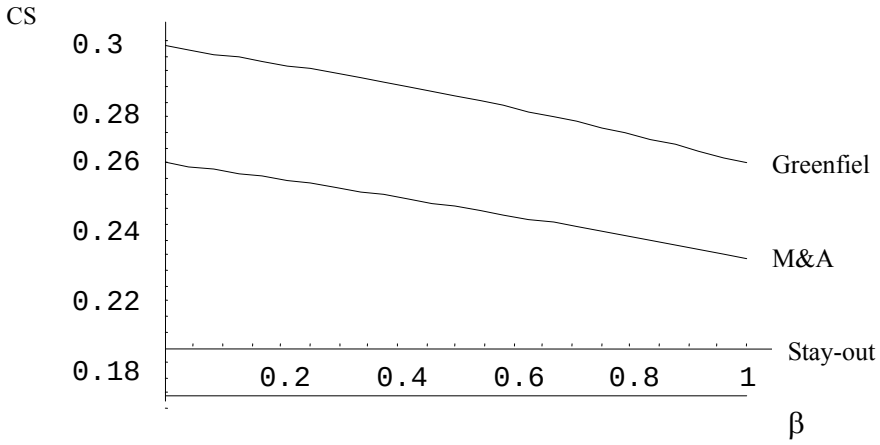

Figure 6. Consumer surplus

The consumer surplus in the case of greenfield investment is greater than that in the M&A and staying-out strategies for any value of β. Figure 7 shows the total profits of the local firm(s). The total profits in the M&A case exceed those under greenfield investment for any value of β. With a relatively high β, the profits of the local firms in M&A are larger than the case in which the potential entrant chooses to stay out.

We next sum up the consumer surpluses and total profits to calculate the host country's welfare for each strategy. Figure 8 shows that for a very low β, the total welfare of staying out is the best and greenfield investment is the worst. The total welfare of M&A becomes greater as β increases. However, in some areas of β, the welfare of greenfield investment exceeds the welfare of M&A and in the very high β area, the welfare of M&A is the best among the three options.

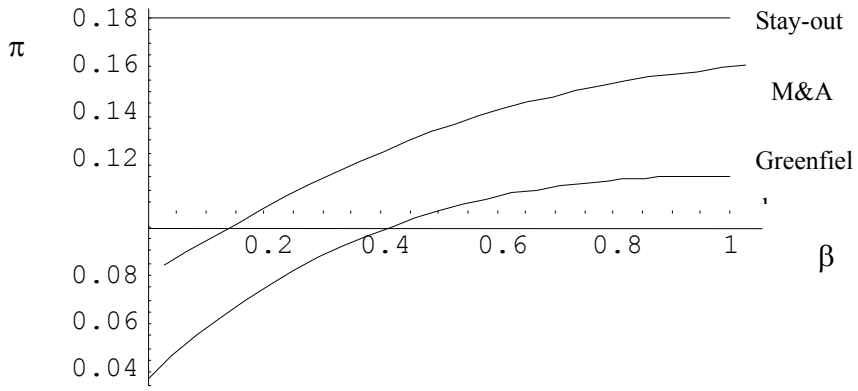

Figure 7. Total profits

The economic intuition of the above results is as follows. The entry of a foreign firm probably reduces consumers' prices as well as the total profits of the local firms. The change in the social welfare of the host country depends on the difference between an increase in consumer surplus and a decrease in producer surplus. When β is very low, the reduction in the profits of the local firms might dominate the increase in consumer surplus in either the case of greenfield investment or M&A, since the costs of the local firms might not be reduced very much. In addition, under this situation the reduction in the profits of the local firms might be lower in M&A than in greenfield investment, because the R&D level of the entrant firm is smaller in M&A, as shown in Proposition 2, so that the entrant firm's cost advantage originating from R&D spending is relatively lower. As a result, the social welfare of the host country under greenfield investment is lowest.

When β is relatively high, the post-entry increase in consumer surplus might dominate the reduction in the total profits of local firms. Therefore, the social welfare of the host country in both greenfield investment and M&A is higher than the case in which the potential entrant chooses to stay out of the market. In addition, when β is not very high, the entrant firm spends more in R&D when it chooses greenfield investment rather than M&A, as shown in Proposition 2.

As a result, the social welfare is higher in greenfield investment than in M&A. On the other hand, when β is very high, the entrant firm spends less on R&D when it chooses greenfield investment rather than M&A, because of a more serious free-rider or technology leakage problem, as we discussed above. As the post-entry increase in consumer surplus still dominates the reduction in the total profits of the local firms, the social welfare will be higher in M&A than under greenfield investment under this situation.

To sum up, it is demonstrated in the paper that foreign direct investment via greenfield investment is not necessarily better than M&A from the perspective of a host country's social welfare. It depends crucially on the extent of the spillover effects. This result has an important implication for antitrust policy.

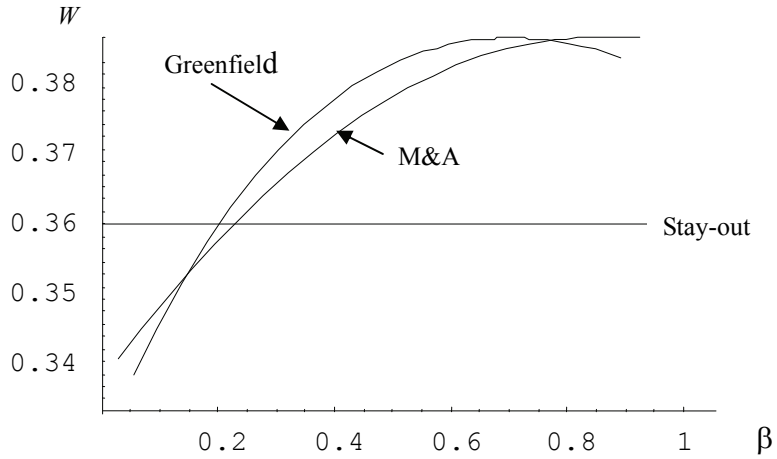

Figure 8. Welfare of the Host Country

4. Conclusion

This paper examined a multinational firm's choice between the different modes of FDI in cooperation with R&D spillovers from the multinational to a local firm. We then developed a three-stage game-theoretical model to examine the relationship between a firm's level of R&D

with spillovers and its choice of foreign market entry modes.

We found that the choice of entry mode of the multinational firm crucially depends on the magnitude of R&D spillovers as well as the cost differences in entry modes. Our model, in particular, predicts that, with relatively high R&D spillovers and relatively small difference in cost between M&A and greenfield FDI, an R&D-intensive firm tends to choose greenfield investment rather than M&A. On the other hand, with relatively small R&D spillovers, a multinational firm is more likely to prefer M&A to greenfield investment. It was also shown that the level of social welfare in the host country depends on the magnitude of technology spillovers. With moderate R&D spillovers, social welfare with greenfield investment is better than that of M&A together with higher consumer surplus, while the total profits of the firms are higher in M&A than in greenfield investment.

These findings lead to an important implication, particularly for antitrust policy of developing countries. To promote their economic growth, developing countries have been trying to absorb FDI from developed countries. While in the situation with high R&D spillovers, foreign firms with strong technological advantages are likely to set up greenfield investment ventures to avoid the leakage of their technology, social welfare of the host country may decline compared to M&A. This tradeoff will become more important in the world in which cross-border M&A has become the common mode of FDI by multinational enterprises.

Appendix A: Extension to Include the Export Option

In the case of an export strategy, the foreign firm must pay a transport cost when it exports to the local market. The profit function of the foreign firm is thus $\pi_E^* = \max_{q^*}\left[\left(p - c_m - t\right)q^*\right]$, where $0 < t$. If foreign firm chooses to export as an entry mode, then players' profits become:

$$\pi_E^* = \frac{1}{16}\left[\alpha + 2c_d - 3c_m - 3t\right]^2 \quad \text{for the foreign firm,} \tag{A1}$$

$$\pi_{E1} = \pi_{E2} = \frac{1}{16}\left[\alpha - 2c_d + c_m + t\right]^2 \quad \text{for the first and the second local firms.} \tag{A2}$$

Solving the profit maximization problems for each firm, we have the optimal R&D expenditure of the foreign firm:

$$\tilde{r}_E(\beta) = -\frac{(c - \alpha + 3t)(2\beta - 3)}{-7 - 12\beta + 4\beta^2}. \tag{A3}$$

Compared with the optimal R&D level of greenfield investment, the R&D level of exports is lower than the level of greenfield investment by $3t$. Specifically, the optimal R&D level is negative if the transportation cost is large or when $t > (\alpha - c)/3$.

Substituting the optimal R&D into the profit functions, we have:

$$\pi_E^*(\beta, t) = \frac{16(c + 3t - \alpha)^2}{(7 - 2\beta)^2(1 + 2\beta)^2}, \tag{A4}$$

$$\pi_{Ei}(\beta, t) = \frac{[(c - \alpha)(-1 - 5\beta + 2\beta^2) + t(4 - 3\beta + 2\beta^2)]^2}{(7 - 2\beta)^2(1 + 2\beta)^2}, \quad i = 1, 2. \tag{A5}$$

The foreign firm has another additional option, to export, in the third stage. In this stage the foreign firm chooses the greatest among π_G^*, π_E^*, and π_N^*. At this time, the entrant firm's

choice depends on three parameters: β, γ, and t. Hence, incorporating the export option into the model makes our analysis more complicated without changing our main conclusions.

Appendix B: Proof of Proposition 1

Differentiating $r_i(\beta)$ with respect to β, we have:

$$r_A'(\beta) = \frac{(c-\alpha)(13-4\beta+\beta^2)}{(-5-4\beta+\beta^2)^2}, \tag{A6}$$

$$r_G'(\beta) = \frac{2(c-\alpha)(25-12\beta+4\beta^2)}{(7+12\beta-4\beta^2)^2}. \tag{A7}$$

Since (c-α) is negative, we have the following relationships: $r_A'(\beta)<0$ if $(13-4\beta+\beta^2)>0$ and $r_G'(\beta)<0$ if $(25-12\beta+4\beta^2)>0$. It is easy to show that $(13-4\beta+\beta^2)>0$ and $(13-4\beta+\beta^2)>0$ for $0 \le \beta \le 1$. Thus, $r_i'(\beta)$, $i=A,G$, is a monotonously decreasing function of β.

We know that $r_A(1) = (\alpha - c)/8 > 0$ and $r_G(1) = (\alpha - c)/15 > 0$. Hence, $r_i(\beta)$, $i=A,G$, are strictly positive for $\beta \in [0,1]$. □

Appendix C: Proof of Proposition 2

From Appendix B and the values of $r_i(0)$, $i=A,G$, the proof is obvious. □

Appendix D: Proof of Proposition 3

In the third stage the foreign firm chooses either greenfield investment or a stay-out strategy according to the sign of π_G^*. In our notation:

$$\overline{\pi}_G^* = \begin{cases} \pi_G^* > 0, \ if \ \ 0 \le \beta \le \widetilde{\beta}(\gamma) \\ \\ \pi_G^* < 0, \ if \ \ \widetilde{\beta}(\gamma) \le \beta \le 1, \end{cases} \tag{A8}$$

where $\widetilde{\beta}'(\gamma) > 0$.

In the second stage the first local firm compares the reservation profit ($\overline{F}$) with the profit of greenfield investment (π_{G1}) if the foreign firm chooses greenfield investment in the third stage ($\pi_G^* > 0$). If the foreign firm chooses to stay out in the third stage ($\pi_G^* < 0$), then the first local firm always rejects the M&A offer, because of the assumption that $\overline{F} < \pi_{N1}$. Hence, we have three possible SPNEs, i.e. {the foreign firm chooses $\tilde{r}_A(\beta)$, the first local firm accepts the offer}, {the foreign firm chooses $\tilde{r}_G(\beta)$, the first local firm rejects the offer, the foreign firm chooses greenfield investment}, and {the foreign firm makes an M&A offer, the first local firm rejects the offer, the foreign firm chooses to stay out}. □

References

Bertrand , Olivier and Pluvia Zuniga. 2006. “R&D and M&A: Are cross-border M&A different? An investigation on OECD countries,” *International Journal of Industrial Organization*. 24: 401– 423.

Buckley, Peter, J., and Casson, Mark. 1998. “Analyzing Foreign Market Entry Strategies: Extending the Internalization Approach,” *Journal of International Business Studies*, 29: 539-561.

Cloodt, Myriam. Hagedoorn, John, and van Krannenburg, Hans. 2006. “Mergers and acquisitions: Their effect on the innovative performance of companies in high-tech industries,” *Research Policy*, 35(5), 642–654.

Coe, David, T. and Helpman, Elhanan. 1995. “International R&D Spillovers,” *European Economic Review*, 39: 859-887.

Coe, David T, Helpman, Elhanan, and Hoffmaister, Alexander W. 1997. "North-South R&D Spillovers," *Economic Journal*, 107(440): 134-49.

Görg, Hlger. 2000. Analyzing Foreign Market Entry: The Choice Between Greenfield Investment and Acquisitions. *Journal of Economic Studies*, 27: 165-181.

Hijzena, Alexander, Gorg, Holger, and Manchin, Miriam. 2008. “Cross-border mergers and acquisitions and the role of trade costs,” *European Economic Review*, 52 (5): 849–866.

Keller, Wolfgang and Yeaple, Stephen R. 2009., “Multinational Enterprises, International Trade, and Productivity Growth: Firm Level Evidence from The United States,” *Review of Economics and Statistics*, 91 (4): 821-831.

Kim, Young-Han. 2009. “Cross-border M&A vs. Greenfield FDI: Economic Integration and Its Welfare Impact, *Journal of Policy Modeling*. 31: 87-101.

Lall, Sanjaya. 2002. “Implications of Cross-Border Mergers and Acquisitions by TNCs in Developing Countries: A Beginner’s Guide,” QEH Working Paper Series, University of Oxford.

Liu, Xiaohui and Huan Zou. 2008. “The impact of greenfield FDI and mergers and acquisitions on innovation in Chinese high-tech industries,” *Journal of World Business* 43: 352–364.

Nocke, Volker and Stephen Yeaple. 2007. Cross-border Mergers and Acquisitions vs. Greenfield Foreign Direct Investment: The Role of Firm Heterogeneity," *Journal of International Economics*, 72: 336–365.

Petit, Maria-Luisa, and Sanna-Randaccio, Francesca. 2000. Endogenous R&D and Foreign Direct Investment in International Oligopolies. International *Journal of Industrial Organization*, 18: 339-367.

Porrini, Patrizia. 2004. "Can a Previous Alliance Between an Acquirer and a Target Affect Acquisition Performance," *Journal of Management*. 30(4): 545–562.

Raff, Horst, Michael Ryan, and Frank Stahler. 2009. "The Choice of Market Entry: Greenfield Investment, M&A and Joint Venture," *International Review of Economics and Fiance*, 18: 3-10.

Ruckman, Karen. 2005. "Technology sourcing through acquisitions: evidence from the US drug industry," *Journal of International Business Studies*. 36: 89–103.

Shimizu, Katsuhiko, Hitt, Michael A., Vaidyanath, Deepa, and Pisano, Vincenzo. 2004. "Theoretical Foundations of Cross-Border Mergers and Acquisitions: A Review of Current Research and Recommendations for the Future," *Journal of International Management,* 10: 307-353.

Yokota, Kazuhiko and Tomohara, Akinori. 2010. "Modeling FDI-induced Technology Spillovers," *The International Trade Journal*, 24(1): 5-34.

GIARI Working Paper Vol. 2010-E-1,
April 2010
Published by Waseda University Global COE Program
Global Institute for Asian Regional Integration (GIARI),
Waseda University, Nishiwaseda Bldg. 5F#507 1-21-1
Nishi-waseda, Shinjuku-ku, Tokyo 169-0051 Japan
E-mail: affairs@waseda-giari.jp
Webpage: http://www.waseda-giari.jp
Printed in Japan by TRY-EX Inc.