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Technology Transfer and Competition: Does Mode of Foreign Entry Matter?*

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Greenfield FDI is often regarded as having more beneficial effect on the host economy than M&A. However, recent evidence shows that there may not be such a great difference between the two modes. This paper empirically tests some theoretical conclusions regarding entry mode decision and technology transfer. The results show that cross border M&A is more likely to occur, the lower the technology transfer cost. Also, the likelihood of M&A occurring increases with competition when competition level is low and decreases with competition when competition level is high. The results were however not statistically significant, suggesting that differences between the two entry modes are not very strong in practical terms.

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1. INTRODUCTION

There is a long time belief that benefits to host country from foreign investment is greater under Greenfield compared to mergers and acquisitions (M&As). It is argued that Greenfield brings in additional capital, contributing to new capital formation, technology transfer and employment whereas M&A simply means a change of ownership. Greenfield also increases competition while M&A reduces competition. This belief is reflected in policy that discriminates in favor of Greenfield investment, but against M&A. For example, tax exemption is allowed for Greenfield investment, but not for M&A. Sometimes, M&A is banned outright.

The impact of Greenfield investment and M&A is clear with respect to competition, but what about the impact on technology transfer?[1)] It is not so clear a priori, why technology transfer should be greater, and therefore the benefits of the host country be greater under Greenfield. The UNCTAD (2000) survey suggests there may not be such a great difference between modes of FDI in the long run. Follow-on-investment, technology transfer and employment generation can be high for the acquired firm. In a study of OECD countries over the period 1990-1999, Bertrand and Zuniga (2006) shows that cross-border M&As did not necessarily stifle host country R&D, and that while domestic M&As stimulated R&D investment in low-technology intensive industries, cross-border M&A tended to stimulate R&D investment in medium technology intensive industries. In the face of recent evidence, it would be unreasonable to continue policies discriminating one mode of entry against the other without further clarification.

Two strands of literature relate to the issue of how technology transfer by MNCs may differ depending on the different modes of entry. The first strand is the international trade literature that considers technology transfer through FDI under strategic environment. Following this tradition, Wang

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[1)] It is not even clear with respect to competition. Sometimes, M&A can encourage competition by inducing new entry or by preventing an existing player from exiting the market (Yun, 2001). On the other hand, Greenfield entry can result in higher concentration if it induces domestic firms to merge or to leave the market (Haller, 2004).

and Blomstrom (1992) develop a model of international technology transfer once the MNC has decided to invest. Assuming that technology transfer is costly, they show that the rate of modern technology transfer is greater, the greater the competitive pressure in the host country (i.e., greater the resources invested in learning by host country firms). While this model provides insights regarding the technology transfer process through FDI, it does not consider the role of entry mode decisions in this process.

Ethier and Markusen (1996) show that direct investment is preferred to licensing when the knowledge capital is of medium or high importance relative to physical capital. In their model, the fixed cost of producing in the foreign country can be interpreted as the relative importance of knowledge capital to physical capital. Increase in the fixed cost implies a decrease in the importance of knowledge capital to physical capital, or an increase in the costliness of technology transfer (i.e., greater amounts of additional R&D have to be done locally to use the new technology transferred from headquarters), or a decrease in the foreign market size. Their focus however, lies on the decision to license or FDI, and do not include the Greenfield versus M&A decision.

The second strand of literature explores MNC's choice to enter through Greenfield investment or M&A. Raffe, Rayan, and Stahler (2009) show that mode of entry decision is largely determined by the profitability of Greenfield investment. Profitability of Greenfield investment lowers acquisition price, and the foreign firm chooses to enter through M&A as long as the fixed cost associated with M&A is sufficiently low. Nocke and Yeaple (2007) consider the mode of entry decision under firm heterogeneity. There are two groups of firms: firms with mobile capabilities (e.g., technological or organizational capability) and immobile capabilities (e.g., knowledge of local market conditions or taste, and relationships with local buyers and suppliers). The model predicts that firms with different capabilities choose different modes of entry. In an industry where firms differ in mobile factors (e.g., R&D intensive industry), the most efficient firms engage in cross-border M&A, less efficient firms engage in Greenfield

FDI, while the least efficient firms export. In an industry where firms differ in immobile capabilities (e.g., advertising intensive industry), the most efficient firms choose Greenfield FDI, less efficient exports and the least efficient, cross-border M&A. Neary (2008) explains merger waves by showing how trade liberalization encourages M&As, with the low-cost home firm buying up high cost foreign firm in the expanded market. These studies, while explaining the conditions under which entry mode decisions are made, do not address the technology transfer issue.

Relatively few studies explore the relationship between mode of FDI entry and technology transfer. Gorg (2000) develops a model of mode of FDI entry decision under asymmetric duopoly in the case of a non-traded good. The study concludes that Greenfield investment leads to increasing competition, yielding higher total output and lower prices in the market. If the costs for acquiring market knowledge in the foreign market are relatively low compared to costs for product adaptation, a foreign firm may be better off entering the market via Greenfield investment rather than M&A. However, under most conditions, the take-over of the existing indigenous high-technology firm is the preferred mode of market entry. Although higher output and lower prices under Greenfield implies greater technology transfer under Greenfield, the welfare impact with respect to technology transfer is not explicitly addressed in this study.

According to Muller (2001), Greenfield investment is the optimal mode of entry only if the technological gap between the competitors is sufficiently large. Further, competition intensity within a market can influence the choice of entry mode in a non-monotonous fashion: very low or very high levels of competition makes Greenfield the optimal entry mode, while for intermediate levels, M&A is the optimal mode of entry. Again, this study does not address the question of which mode of entry will yield the more beneficial effect for the host country with respect to technology transfer.

Mattoo, Olarreaga, and Saggi (2004) develop a model in which the incentive to transfer technology differs between modes of entry, and this difference depends on the degree of competition in the host country market

and the cost of technology transfer. The conditions under which more technology is transferred under each different modes of entry are specified, and compared to the foreign firm's own preference of entry mode. When publicly desired entry mode differs from the foreign firm's private preference, there are rooms for government intervention to favor one or the other entry mode. As far as the author can tell, no study has yet been done regarding technology transfer and mode of FDI entry into Korea. Existing study on FDI mode of entry such as Lee and Yun (2006) relates to firm performance by mode of FDI entry, rather than factors determining mode of entry decision.[2)]

The current paper attempts to empirically test some of the conclusions arising from this model, which specifically addresses the technology transfer issue and mode of FDI entry decision simultaneously. The next section explains the model in greater detail and develops the hypothesis to be tested. Section 3 discusses the empirical methodology, the variables, and data. Section 4 presents the results from the empirical analysis, and section 5 concludes.

2. THE MODEL

In Mattoo *et al*. (2004: MOS, hereafter)'s model,[3)] amount of technology the foreign firm transfers depends on the cost of technology transfer τ and the level of competition in the host country market. Since the incentive to transfer technology is greater when market share is higher (there is greater opportunity to profit from the technology), technology transfer is less with increasing competition. This by itself would imply that the incentive to transfer technology is higher under M&A since entry through M&A decreases competition while entry through Greenfield will increase competition.

[2)] For a study of ownership structure in joint ventures by Korean multinationals, see Chun (2008). This study, however, does not analyze mode of entry decision by multinationals.

[3)] The core equations of the model are provided in the Appendix.

However, there is also the strategic effect. When the level of technology transfer is decided before quantities, firms have strategic incentives in deciding on technology transfer. This is because technology transfer not only increases profit due to own cost reduction, but also through lowering the quantities of competing firms. The strategic effect increases with competition up to a certain critical level, and then decreases with competition thereafter. This is because when the market is highly concentrated, there is little room for strategic interaction, and the strategic effect has little impact. Under oligopolistic market, the strategic effect becomes more important, but as the market approaches perfect competition levels, strategic effect again disappears. The strategic effect therefore implies that when the level of competition is low, the strategic incentive to transfer technology is greater under Greenfield as this mode of entry increases competition, whereas when the level of competition is already high, the strategic incentive to transfer technology will be greater under M&A.

The strategic effect is reinforced by low technology transfer cost. If it is not so costly to transfer technology, the foreign firm will have the incentive to strategically transfer technology just to lower the output of rivals, even if it may not greatly lower the firm's own production cost or enhance the quality of its products. This suggests that with low technology transfer cost, the strategic effect becomes stronger and if the level of competition is low, the incentive to transfer technology is greater for Greenfield entry. In summary, when the technology transfer cost *and* the level of competition are *both* low, Greenfield entry is the more desirable mode of entry from the host country perspective.

The foreign firm may not however, always enter through the more desirable mode. The firm enters through the most profitable mode of entry. The respective profits depend on the cost of acquisition and the effect on profit through competition reduction under the acquisition mode. How do the levels of competition and technology transfer cost affect the entry mode decision?

When competition level is low, the foreign firm will increasingly prefer to

Table 1 Effect of Technology Transfer Cost and Competition on Mode of Entry

	Low Transfer Cost, Low Competition	High Transfer Cost, High Competition
Technology Transfer (x)	GF > MA	MA > GF
Profits (π)	MA > GF	GF > MA

enter through M&A as competition increases, since the competition reduction effect is great and the foreign firm can enjoy higher market share than if it entered through Greenfield. On the other hand, when competition level is high, the foreign firm will increasingly prefer to enter through M&A as competition decreases, since the impact of competition reduction through acquisition is now not so great. There will be many more domestic firms to compete with. This implies that the probability of the foreign firm entering through M&A will first increase with competition, but after a critical point, will begin to decline with competition.

At the same time, when the technology transfer cost is high, there will be less technology transfer in general. This makes the profitability of domestic firms higher, raising the acquisition price. Therefore, the foreign firm will prefer to enter through Greenfield. On the other hand, when the technology transfer cost is quite low so that there is a sufficient amount of technology transfer possible, M&A is preferred to Greenfield since the firm gains from competition reduction without raising the acquisition price.

Predictions from MOS are summarized in table 1. When technology transfer cost and the degree of competition is low, the incentive to transfer technology is greater under Greenfield entry than M&A. But profits are higher under M&A, and M&A is more likely to occur than Greenfield. When transfer cost is high and the degree of competition is high, the incentive to transfer technology is greater under M&A than Greenfield, but profits are greater under Greenfield and M&A is less likely to occur.

This implies that the likelihood of M&A occurring will first increase with

competition, but after a critical point decline with competition. Further, this effect will be stronger when technology transfer cost is low, since the strategic effect is reinforced by low technology transfer cost. As long as the transfer cost is below a certain level, there is adequate amount of technology transfer to make domestic firms unprofitable and thereby also lower the acquisition price to affordable levels for M&A. However, the competition reduction effect increases with competition when competition level is low, and decreases with competition when competition level is already high. In the next section, the following hypotheses based on the MOS model are empirically tested, using Korean FDI data for the period 2000-2004.

Hypotheses:

(i) M&A is more likely to occur when technology transfer cost is low. Therefore, the likelihood of M&A occurring will be negatively correlated with technology transfer cost.

(ii) When competition level is low, the foreign firm will increasingly prefer to enter through M&A as competition increases, but after a critical level of competition, when competition level becomes high, the foreign firm will increasingly prefer M&A as competition decreases. Therefore, the likelihood of M&A occurring will first increase with competition, but after a critical point, decline with competition. Moreover, this effect will be stronger when technology transfer cost is lower.

3. EMPIRICAL ANALYSIS

3.1. Methodology and Variables

The above hypotheses that M&A is more likely to occur when technology transfer cost is low, and that it will increase with competition when the competition level is low, but will decrease with competition when competition level is high, can be tested through a logit model such as the

following:

$$Y = a + b_1 \cdot \tau + b_2 \cdot COMP + b_3 \cdot COMPSQ + e,$$

where $Y = 1$ if $\Delta\pi > 0$ (M&A)
$= 0$ otherwise.

The dependent variable Y is a dummy variable taking the value of 1 if mode of entry is M&A and 0, otherwise. The foreign firm enters via the most profitable mode, and so the underlying determinant of Y is the profit difference between the two modes of entry, $\Delta\pi = \pi_{M\&A} - \pi_{Greenfield}$.

The theory predicts that M&A is likely to be more profitable the lower the level of technology transfer cost, τ. The cost of transferring technology is difficult to measure directly. The nature of technology transfer cost is not characterized very well in the MOS model. Technology can be transferred to the subsidiary in many different forms, including technical documentation, education and training of the affiliate labor force, exchange of technical personnel, shipments of machinery and equipment, and on-going communication to solve problems (Kokko and Blomstrom, 1995). Not all of these transfers are recorded and not all of them are priced at market rates. Therefore it is difficult to measure the extent or the amount of technology transferred in the first place, and in the second place, the cost incurred during the transfer process.

Ethier and Markusen (1996) offers an interpretation of fixed cost which is useful for empirical analysis. In their model, high fixed cost of producing in the foreign country is interpreted as lower importance of knowledge capital to physical capital. It indicates that high levels of local research and development has to be incurred to be able to use the technology transferred from headquarters, which means that technology transfer is more costly. The level of fixed cost can be measured by capital intensity (fixed asset divided by number of employees). The greater the capital intensity, the greater the technology transfer cost will be, and this variable should be

negatively correlated with *Y*.

Another prediction of the theory is that when competition level is low, likelihood of M&A occurring increases with competition, but when competition level becomes high, it starts to decline with competition. This calls for including a quadratic term to test for the changing relationship between the likelihood of M&A entry and competition at different levels of competition. Competition here is measured by the number of firms in the industry (at the five digit level) to which the firm belongs. Since greater number of firms indicates greater competition, the competition variable *COMP* should be positively related to *Y*, but the quadratic term *COMPSQ* should be negatively correlated with *Y*.

3.2. The Data

The sample data consists of foreign direct investment cases in Korean manufacturing industries, occuring during 2000-2004. The mode of entry data is acquired from a rare survey undertaken by Lee and Yun (2006). Evidence has been collected from as many sources as possible, including annual corporate financial statements, press articles, and interviews with corporate personnel actually involved in making the deals to determine the mdoe of entry. A mode of entry is Greenfield when a new business is established, making new investment in fixed asset such as manufacturing facilities and equipment. M&As are those acquiring existing stocks and when new stocks are issued by the target firm to foreign investors.

Financial data such as fixed assets and employment are acquired from the Corporate Financial Statement, which these firms are obliged to disclose electronically in the Financial Supervisory Services website. The data on market structure, at the five digit level in the Korean Standard Industrial Classification, comes from Korea Development Institute (2003) and the Korea Fair Trade Commission study of 2006. These data were available for two years, 2000 and 2004. Table 2 shows a summary statistics of the main variables, for the two years separately.

Table 2 Summary Statistics of Variables

Year=2000	Mean	Std. Dev.	Min.	Max.
Investment Amount ($1,000)	86,299.29	124,904.3	11,222	509,582
Fixed Asset (Million Won)	165,859.9	346,735	50	1,476,454
Number of Employees	2,600.077	9,521.863	19	49,023
Number of Firms (5 digit, KSIC)	333.521	569.822	1	2,371
Three Firm Concentration ratio	0.479	0.260	0.125	1
Year=2004	Mean	Std. Dev.	Min.	Max.
Investment Amount ($1,000)	87,551.51	117,305.9	11,222	498,822
Fixed Asset (Million Won)	143,527.4	375,933.4	732	1,810,845
Number of Employees	2,280.579	8,290.137	48	51,000
Number of Firms (5 digit, KSIC)	284.051	415.192	3	1,776
Three Firm Concentration ratio	0.503	0.272	0.125	1

4. ESTIMATION RESULTS

The result of the logit estimation to test the hypotheses presented in the previous section is presented in table 3. The results show that in general, the relationship between variables supports the theory. The first regression (Model 1) is run on a pooled sample, including both years 2000 and 2004. A time dummy, *YEAR*, is included to account for any structural break between the two time periods. It takes the value of 1 for year 2000, and 0 for year 2004. The time dummy is positively signed, suggesting that M&A was more likely to occur in 2000 than in 2004. This is reasonable, considering the fact that there would have been greater opportunities for M&A in the immediate aftermath of the Asian financial crisis, compared to 2004, by which time the Korean economy had recovered. There would have been more firms for sale, and acquisition prices would have been generally lower. The difference between the two years does not seem to be significant, however, as the time dummy is not shown to be statistically significant.

Table 3 Effect of Technology Transfer Cost and Competition on Mode of Entry

Y =1, if M&A 0, otherwise	Model 1	Model 2	Model 3	Model 4
τ	-1.58×10^{-3} (1.93×10^{-3})	-8.581×10^{-4} (8.881×10^{-4})	-6.953×10^{-4} (1.675×10^{-3})	-4.05×10^{-5} (1.391×10^{-3})
COMP	1.05×10^{-3} (1.76×10^{-3})		8.672×10^{-4} (2.345×10^{-3})	
COMPSQ	-3.3×10^{-7} (8.11×10^{-7})		-5.21×10^{-7} (1.38×10^{-6})	
Lowτ.COMP		0.038 (0.024)		0.034 (0.024)
Lowτ.COMPSQ		-2.41×10^{-5}* (1.44×10^{-5})		-2.17×10^{-5} (1.43×10^{-5})
YEAR	0.843 (0.571)	0.62 (0.633)		
Constant	0.078 (0.51)	0.138 (0.395)	0.048 (0.578)	–0.292 (0.475)
	N=61	N=61	N=37	N=37
	Wald $\chi^2(4)$=3.03	Wald $\chi^2(4)$=26.28	Wald $\chi^2(3)$=0.35	Wald $\chi^2(3)$=10.2
	Pseudo R^2=0.0773	Pseudo R^2=0.2238	Pseudo R^2=0.011	Pseudo R^2=0.197

Notes: Figures in ( ) are robust standard errors. * Significant at 10%.

As expected, the technology transfer cost τ, which was proxied by capital intensity, is negatively correlated with the likelihood of M&A occurring. The competition variables also show the expected signs. The competition measured by number of firms is positively correlated with the likelihood of M&A occurring, while the quadratic term is negatively correlated. None of these variables, however, are statistically significant. This suggests that whereas the empirical result generally supports the theory, the effect is not strong enough to be statistically significant.

It should be noted that the theory predicts that the impact of competition is stronger when the technology transfer cost is low. To test for this strategic

effect more explicitly, the second regression replaces the competition variables with those interacted with a dummy variable indicating low technology transfer cost. This dummy variable takes a value of 1 when capital intensity is below the 50th percentile. The competition variables are interacted with this dummy variable to get the interacted competition variables *LowτCOMP* and *LowτCOMPSQ.*

Both the interacted variables have coefficients with expected signs, again suggesting that the likelihood of M&A first increases with competition, and then declines with competition. Moreover, the coefficients become larger when interacted with technology transfer cost dummy, as predicted by theory. The quadratic term even becomes weakly significant. The other variables remain statistically insignificant.

Model 3 and Model 4 are results from regressions run on the sub-set of the sample including only year 2004. Regression results are essentially the same. The coefficients carry the expected signs, but are not statistically significant. The competition effects are again stronger when interacted with technology transfer cost dummy. This suggests that there is no significant structural break between the two time periods, and the results from the pooled sample, with the benefit of greater numbers of observation, is reliable.

5. CONCLUSION

Overall, the estimation results generally support the hypothesis with respect to the relationship between mode of FDI entry, technology transfer cost and competition. Even though the coefficients are not statistically significant, they all carry the predicted signs. M&A is generally more likely to occur the lower the technology transfer cost. At the same time, the likelihood of M&A occurring is greater when competition level is low. More specifically, the likelihood of M&A occurring increases with competition when competition level is low, and decreases with competition when the competition level is high. This effect is stronger, when

technology transfer cost is lower. These results support the hypothesis presented in section 2.

According to theory, the circumstance under which M&A is more likely to occur is exactly when the foreign firm will have lower incentive to transfer technology under M&A. This could not be explicitly tested for empirically due to lack of data on technology transfer activities at the firm level. However, a real life example may be the contrasting technology transfer processes of two FDI cases, one entering as M&A and the other as Greenfield.

Celltrion entered the Korean market as a joint venture between Vax Gen, a California based biotechnology firm and three Korean investors in 2002. Green Cross Vaccine Corporation was established by the Korea Green Cross Corporation in 1999. In 2000, Rhein Biotechnology bought 80% of its equity in a strategic alliance. Then in 2002, it became a subsidiary of the Berna Biotechnology when Berna merged with Rhien.

Both Celltrion and Green Cross Vaccine belong to the same industry, biopharmaceutical manufacturing (KSIC D24212). The technology transfer cost in this industry is not expected to be too high. It is well known that although the pharmaceutical industry is highly R&D and capital intensive, knowledge in this industry can be easily codified into a formula, once a new substance is innovated. That is, the technology can be characterized as explicit. Explicit knowledge can be better protected by patents than implicit knowledge, and is therefore easier and less costly to transfer.[4)] Further, since Korean pharmaceutical manufacturing abilities are fairly advanced and intellectual property rights law is well in place, technology transfer cost in this industry at the receiving end is also not expected to be very high. At the same time, this industry is a concentrated industry, with the three firm concentration ratio being as high as 68% in 2000, and greater than 75% in 2004. So, this is a case (low technology transfer cost, low competition) where M&A is more likely to occur, but has less strategic incentive to

[4)] The explicit-implicit knowledge dichotomy is here loosely defined. For a critique of how these concepts are used in economics, see Cowan, David, and Foray (2000).

transfer technology.

Celltrion, entering as a Greenfield joint venture, is the aberrant case, and should be transferring technology more aggressively than Green Cross Vaccine Corporation. This seems to be true, at least at the time of entry. In the case of Celltrion, manufacturing is based mainly on Vax Gen technology (AIDS vaccine) from the start, and plans for new future products are based on technology to be transferred from Vax Gen, although Celltrion itself will also conduct biopharmaceutical research. In the case of Green Cross Vaccine Co., which already had a history of producing the Hepatitis-B vaccine and combined vaccines, was made to refocus on these core activities, rather than immediately launching into new products with new technology coming from the foreign investor.

If greater technology transfer is the goal of governments, theory suggests that governments could give incentives to induce the kind of entry mode that has the greater strategic incentive to transfer technology but is not likely to occur given the level of transfer cost and competition. That is, the rationale for government intervention is not because any one mode of entry is always better or worse for technology transfer, but because in both cases, depending on the levels of technology transfer cost and competition, the mode that is more likely to occur does not transfer technology as much as the other mode of entry. For example, Celltrion benefitted from some government support when it located its facilities in the Incheon Free Economic Zone, under a situation when mode of entry would more likely to have been M&A, with weaker incentives to transfer technology. It is interesting to note that Greenfield occurred through a joint venture, which is similar to mergers in that for both entry modes, the motivation is to benefit from synergies between the foreign investor and the domestic partner. In industries where technology transfer cost is high but the market is competitive, barriers against M&A could be lowered so as to induce M&A, which is less likely to occur but has greater incentives to transfer technology, without impairing competition too seriously.

While the estimation results from this paper suggest that relationships

between the variables of interest generally support theory, they also indicate the strength of the relationship is barely significant. That is, the impact of technology transfer cost and competition on mode of entry decision may not be strong enough to warrant adopting a clearly distinct policy towards M&A as opposed to Greenfield FDI. This is not surprising, given the recent evidence suggesting the lack of large differences in economic impact by different FDI entry modes. The policy implication is that governments should be cautious in introducing regulation discriminating between Greenfield and M&A. Such policies may not be as effective as suggested by theory, given that the difference in economic impact of the different modes of entry may not be very strong in practical terms.

The results of this paper can only be taken as preliminary. Main shortcomings of the analysis originate from limitations in the data. The current data set does not have information on technological activities at the firm level, preventing a more direct measure of extent of technology transfer and technology transfer cost. This prevents the testing of the differential strategic impact of Greenfield and M&A with respect to technology transfer. Further, the survey containing information on mode of entry categories at the firm level gave a very small sample of usable data. Nevertheless, this data set is a rare one to come by, and this paper attempted to exploit the available information as fully as possible.

APPENDIX: THE MODEL

A1. Product Market Competition

The model assumes a basic Cournot competition with the following profit function, where π is profit, p is price, q is quantity, c is cost, a is a constant, and the subscript i represents the ith firm, and $-i$, all other firms:

$$\pi_i(q_i, q_{-i}) = (p(q) - c_i)q_i = (a - q_{-i} - q_i - c_i)q_i.$$

The cost of the domestic firm is just *c*, while the cost of the foreign firm is $c-x$, so that its costs fall as it transfers more technology. There is cost to transfer technology, however, which increases with the amount of technology transferred *x*, and a cost parameter τ as follows:

$$C(x)=\tau\cdot\frac{x^2}{2},\quad \tau=\frac{\partial^2 C}{\partial x^2}.$$

Solving for quantities gives the output levels of the foreign and domestic firms under M&A and Greenfield FDI, where *n* is number of firms, *A* denotes M&A, *E* denotes Greenfield, *f* denotes foreign firm and *h* denotes domestic firm:

$$q_f^A=\frac{a+(n-1)x-c}{n},\ q_h^A=\frac{a-c-x}{n},\ q_f^E=\frac{a+nx-c}{n+1},\ q_h^E=\frac{a-c-x}{n+1}.$$

Using the profit function and the quantities, the profits of foreign and domestic firms under each mode of FDI entry are shown to be:

$$\pi_f^E(x^E)=\frac{(a-c)^2\tau}{2n(\tau-n)+\tau(n^2+1)},\ \pi_h^E(x^E)=\left[\frac{(a-c)(\tau n-2n+\tau)}{2n(\tau-n)+\tau(n^2+1)}\right]^2,$$

$$\pi_f^A(x^A)=\frac{(a-c)^2}{2n(2-n)+\tau n^2},\qquad \pi_h^A(x^A)=\left[\frac{(a-c)(\tau n+2-2n)}{2n(2-n)+\tau n^2}\right]^2.$$

A2. Technology Transfer

The first order condition for technology transfer under Greenfield is written as follows:

$$\frac{\partial\pi_f^E}{\partial q_f}\cdot\frac{\partial q_f^E}{\partial x}+(n-1)\frac{\partial\pi_f^E}{\partial q_h}\cdot\frac{\partial q_h^E}{\partial x}+\frac{\partial\pi_f^E}{\partial x}-\frac{\partial C(x)}{\partial x}=0.$$

The second term represents the strategic effect: the change in profit of the foreign firm due to the change in output of the domestic firm, which in turn is a response to the technology transfer by the foreign firm. Using the profit function to obtain the derivatives of the profits, the strategic effect can be rewritten as follows for Greenfield entry and M&A entry respectively:

$$S^E = (n-1)\left(-q_f^E\right)\frac{\partial q_h^E}{\partial x} + q_f^E - \tau x = 0,$$

$$S^A = \frac{n-2}{n}\cdot q_f^A + q_f^A - \tau x = 0.$$

Replacing the quantities from above, the strategic effect can be expressed in terms of number of firms and technology transfer cost. It is shown to be concave in n, while decreasing in τ.

$$\frac{\partial S(n,\ \tau)}{\partial \tau} = -\frac{-2(n-1)(a-c)n^2}{(-2n^2+\tau n^2+2\tau n+\tau)^2},$$

$$\frac{\partial S(n,\ \tau)}{\partial n} = \frac{-(a-c)(-2n^2+\tau n^2-2\tau n-3\tau+4n)\tau}{(-2n^2+\tau n^2+2\tau n+\tau)^2}.$$

From this, the critical number of firms beyond which the strategic effect begins to decline with respect to number of firms, n^c, is given by:

$$n^c(\tau) = \frac{\tau-2+\sqrt{2}\sqrt{(\tau-2)(2\tau-1)}}{\tau-2}.$$

Solving the equations for strategic incentives yields x, the extent of technology transfer under the two modes of entry respectively:

$$x^E = \frac{2n(a-c)}{(\tau-2)n^2+(2n+1)\tau},\ \ x^A = \frac{2(n-1)(a-c)}{(4n-2)+(\tau-2)n^2}.$$

The foreign firm transfers equal amount of technology when the critical transfer cost parameter τ is $\tau_t(n) = 2n(n-1)/(n^2-n-1)$. That is, technology transferred is less under acquisition if $\tau < \tau_t(n)$.·

A3. Entry Mode Decision

The foreign firm chooses to enter through M&A if profit under M&A is greater than under Greenfield as follows, where $\pi_h^A(x^A)$ is the buyout price the acquiring firm has to pay:

$$\Delta\Pi = \pi_f^A(x^A) - C(x^A) - \pi_h^A(x^A) - [\pi_f^E(x^E) - C(x^E)] > 0.$$

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