research paper series

Globalisation, Productivity and Technology

Research Paper 2004/25

Foreign Direct Investment Under R&D Competition

by

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The Centre acknowledges financial support from The Leverhulme Trust
under Programme Grant F114/BF

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Acknowledgements

Arijit Mukherjee acknowledges financial support from The Leverhulme Trust under Programme Grant F114/BF

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Abstract

We consider the preferences of a foreign firm and a welfare maximizing host country government for foreign direct investment through direct entry and acquisition in presence of innovation by the firms. We find that relatively superior technology is always used under acquisition. Though profits are higher under acquisition, consumers are better off under direct entry, which creates a tension on the host country welfare. The host country welfare is higher under acquisition if the bargaining power of the foreign firm and the slope of the marginal cost of R&D are sufficiently low. Otherwise, the host country welfare is higher under direct entry.

JEL Classification: F13 ; F23 ; 032

Key Words: Acquisition; Foreign direct investment; R&D; Welfare

Outline

Non-Technical Summary

The benefit of foreign direct investment (FDI) may depend on the particular mode of FDI. This paper sheds light on the relationships between the mode of FDI, quality of the technology and the host country welfare.

We find that relatively superior technology is always used under acquisition. Though profits are higher under acquisition, consumers are better off under direct entry, which creates a tension on the host country welfare. The host country welfare is higher under acquisition if the bargaining power of the foreign firm and the slope of the marginal cost of R&D are sufficiently low. Otherwise, the host country welfare is higher under direct entry.

1. Introduction

The benefit of foreign direct investment (FDI) may depend on the particular mode of FDI. We consider a simple model with two types of FDI, viz., direct entry and acquisition, to shed light on the relationships between the mode of FDI, quality of the technology and the host country welfare.

We find that relatively superior technology[1] is always used under acquisition and the profits are higher under acquisition than direct entry. Therefore, firms always prefer acquisition than direct entry. However, consumers prefer the opposite, which creates a tension on the host country welfare. We show that the host country welfare is higher under acquisition if the bargaining power of the foreign firm and the slope of the marginal cost of R&D are sufficiently low. Otherwise, the host country welfare is higher under direct entry. Hence, our results have important implications for FDI policies and show the importance of bargaining power of the firms and the cost of R&D.

Our paper is related to the recent work of Mattoo et al. (forthcoming), which also addresses a similar question.[2] Unlike them, we find that relatively superior technology is *always* used under acquisition and the host country welfare is lower under acquisition *only if* the slope of the marginal cost of R&D is sufficiently low.

Our analysis differs from Mattoo et al. (forthcoming) in two important ways. Firstly, we allow the domestic and the foreign firms to do R&D, whereas they consider R&D by the foreign firm only. Secondly, we consider bargaining between the firms rather than considering full bargaining power of the foreign firm.[3] Therefore, while our paper is suitable for the countries with similar innovative capabilities (e.g., between the developed or the newly industrialized countries), their work fits well for the countries with asymmetric innovative capabilities (e.g., between the developed and the developing countries).

The present paper also extends the literature on technology transfer and direct entry (see, e.g., Lee and Shy, 1992, Ethier and Markusen, 1996, Saggi, 1996, 1999, Markusen, 2001 and Mukherjee, 2000), and international merger (e.g., Barros and Cabral, 1994, Head and Ries, 1997, Roy et al., 1999, Das and Sengupta, 2001 and

[1] We define technology by the cost of production. Better technology implies lower cost of production.
[2] Ferrett (2003) focuses on direct entry and acquisition by two competing foreign firms.

Horn and Levinsohn, 2001). However, the former set of papers does not focus on different types of FDI considered in this paper and the latter set of papers does not consider endogenous technology choice by the firms.

The remainder of the paper is organized as follows. We describe the model and show the results in section 2. Section 3 concludes.

2. The model and the results

Assume that there is a firm, firm 1, who wants to invest in a country, called domestic country. Firm 1 has to compete in the domestic country with a domestic firm, firm 2. Assume that the firms produce homogeneous products.

We assume that the inverse market demand function is

$$P = a - q, \tag{1}$$

where q is total output of firms 1 and 2.

Assume that the firms have similar technologies at the beginning and each firm has the constant average cost of production c. However, both firms do R&D to reduce their own cost of production. We assume that x amount of investment in R&D by firm i, $i = 1,2$ reduces its cost of production to $(c - x_i)$. For simplicity, we restrict our attention to the situation where $c \geq x_i$. However, R&D is costly and the cost function for R&D is $C(x_i) = \frac{\tau x_i^2}{2}$. As τ increases, it increases the cost of R&D for a given R&D investment. We assume that there are no other costs of doing R&D.

We consider the following game. At stage 1, firm 1 decides whether to do FDI through direct entry or acquisition. If firm 1 does FDI through direct entry, both firms invest simultaneously in R&D at stage 2. Then, at stage 3, they compete like Cournot duopolists and the profits are realized. But, under acquisition at stage 1, firm 1 pays a transaction price, F, to firm 2, at stage 2. We assume that the generalized Nash bargaining process determines the transaction price. Then, at stage 3, firm 1 decides its R&D investment. At stage 4, firm 1 chooses its output and the profit is realized. We solve the game through backward induction.

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[3] See, e.g., Mukherjee (2000, 2002) and Das and Sengupta (2001) for other works where the domestic and the foreign firms have positive bargaining power.

2.1 The analysis under direct entry

Let us first consider the game under direct entry at stage 1. Given the R&D investments at stage 2, firms 1 and 2 choose outputs to maximize the following expressions respectively:

$$\underset{q_1}{Max}(a-q-c+x_1)q_1-\frac{\tau x_1^{\,2}}{2} \tag{2}$$

$$\underset{q_2}{Max}(a-q-c+x_2)q_2-\frac{\tau x_2^{\,2}}{2}, \tag{3}$$

where q_1 and q_2 are outputs of firms 1 and 2 respectively.

We find that optimal outputs of firms 1 and 2 are respectively

$$q_1=\frac{(a-c+2x_1-x_2)}{3} \qquad \text{and} \qquad q_2=\frac{(a-c+2x_2-x_1)}{3}. \tag{4}$$

Optimal net profits (i.e., profits excluding the R&D costs) of firms 1 and 2 are respectively

$$\pi_1^n=\frac{(a-c+2x_1-x_2)^2}{9}-\frac{\tau x_1^{\,2}}{2} \qquad \text{and} \qquad \pi_2^n=\frac{(a-c+2x_2-x_1)^2}{9}-\frac{\tau x_2^{\,2}}{2}. \tag{5}$$

Therefore, at stage 2, firms 1 and 2 maximize following expressions to determine the R&D investments:

$$\underset{x_1}{Max}\frac{(a-c+2x_1-x_2)^2}{9}-\frac{\tau x_1^{\,2}}{2} \tag{6}$$

$$\underset{x_2}{Max}\frac{(a-c+2x_2-x_1)^2}{9}-\frac{\tau x_2^{\,2}}{2}. \tag{7}$$

We find that the optimal R&D investments are

$$x_1^n=x_2^n=\frac{4(a-c)}{(9\tau-4)}. \tag{8}$$

Second order condition for maximization requires that $\frac{8}{9}<\tau$ and we assume that it holds. Note that $x_i^n \le c$ (where $i=1,2$) implies that $\frac{4a}{9c}\le\tau$ and we assume that it holds.

Therefore, total R&D investment is

$$x^n=x_1^n+x_2^n=\frac{8(a-c)}{(9\tau-4)}. \tag{9}$$

We find from (4) and (8) that optimal outputs of firms 1 and 2 are

$$q_1^n = q_2^n = \frac{3\tau(a-c)}{(9\tau-4)}. \tag{10}$$

Therefore, total output and consumer surplus are respectively

$$q^n = \frac{6\tau(a-c)}{(9\tau-4)} \qquad \text{and} \qquad CS^n = \frac{18\tau^2(a-c)^2}{(9\tau-4)^2}. \tag{11}$$

We find from (5) and (8) that optimal net profits of firms 1 and 2 are

$$\pi_1^n = \pi_2^n = \frac{\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2}. \tag{12}$$

Total industry profit is

$$\pi^n = \pi_1^n + \pi_2^n = \frac{2\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2}. \tag{13}$$

Under direct entry, social welfare of the domestic country, which is the summation of consumer surplus and profit of the domestic firm, is

$$W^n = \frac{\tau(a-c)^2(27\tau-8)}{(9\tau-4)^2}. \tag{14}$$

2.2 The analysis under acquisition

Now, consider the game under acquisition at stage 1.

Given the transaction price F^* and the positive R&D investment of firm 1, firm 1 chooses output to maximize the following expression:

$$\underset{q}{Max}(a-q-c+x)q - \frac{\tau x^2}{2} - F^*. \tag{15}$$

We find that optimal output of firm 1 is

$$q^{aq} = \frac{(a-c+x)}{2}. \tag{16}$$

Optimal net profits of firms 1 and 2 are respectively

$$\pi_1^{aq} = \frac{(a-c+x)^2}{4} - \frac{\tau x^2}{2} - F^* \qquad \text{and} \qquad \pi_2^{aq} = F^*. \tag{17}$$

Therefore, at stage 3, firm 1 maximizes following expression to determine the R&D investment:

$$\underset{x}{Max}\frac{(a-c+x)^2}{4} - \frac{\tau x^2}{2} - F^*. \tag{18}$$

Optimal R&D investment is

$$x^{aq} = \frac{(a-c)}{(2\tau-1)}. \tag{19}$$

Second order condition for maximization requires $\frac{1}{2} < \tau$ and this is satisfied since we have already assumed that $\tau > \frac{8}{9}$.

We get that $x^{aq} \leq c$ if and only if $\frac{a}{2c} \leq \tau$ and we assume that it holds. Since $\frac{a}{2c} > \frac{4a}{9c}$, we have two restrictions on τ: (i) $\tau > \frac{8}{9}$ and (ii) $\tau > \frac{a}{2c}$. Since, $\frac{8}{9} \geq \frac{a}{2c}$ for $a \leq \frac{16c}{9}$, the relevant values of τ for our following analysis are $\tau > Max\{\frac{8}{9}, \frac{a}{2c}\}$.

We find from (16) and (19) that total output and consumer surplus under acquisition are respectively

$$q^{aq} = \frac{\tau(a-c)}{(2\tau-1)} \qquad \text{and} \qquad CS^{aq} = \frac{\tau^2(a-c)^2}{2(2\tau-1)^2}. \tag{20}$$

We get from (17) and (19) that optimal profits of firms 1 and 2 are respectively

$$\pi_1^{aq} = \frac{\tau(a-c)^2}{2(2\tau-1)} - F^* \qquad \text{and} \qquad \pi_2^{aq} = F^*. \tag{21}$$

So, total profit is

$$\pi^{aq} = \frac{\tau(a-c)^2}{2(2\tau-1)}. \tag{22}$$

2.2.1 Determination of the transaction price

Now, we are in a position to determine F^*. Since the generalized Nash bargaining process determines F^*, we get it by maximizing the following expression:

$$\underset{F}{Max}\left(\frac{\tau(a-c)^2}{2(2\tau-1)} - F - \frac{\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2}\right)^{\alpha}\left(F - \frac{\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2}\right)^{(1-\alpha)}, \tag{23}$$

where α and $(1-\alpha)$ are the bargaining powers of firms 1 and 2 respectively, where $\alpha \in [0,1]$. Note that the profits under direct entry act as the reservation payoffs for the firms while bargaining for F.

Maximizing (23) we get

$$F^* = \left(\frac{\tau(a-c)^2}{2(2\tau-1)} - \frac{\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2} \right) - \alpha \left(\frac{\tau(a-c)^2}{2(2\tau-1)} - \frac{2\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2} \right). \quad (24)$$

2.3 Comparison of the profits under direct entry and acquisition

It follows from (12), (21) and (24) that the net profits of both firms are higher under acquisition compared to direct entry if and only if

$$\frac{\tau(a-c)^2}{2(2\tau-1)} > \frac{2\tau(a-c)^2(9\tau-8)}{(9\tau-4)^2} \quad (25)$$

or $(9\tau-4)^2 - 4(2\tau-1)(9\tau-8) > 0$. (26)

Condition (25) shows that acquisition is profitable provided the industry profit is higher under acquisition than direct entry. We find that (26) holds for all $\tau > \frac{8}{9}$.

Hence, the following proposition is immediate from the above discussion.

Proposition 1: *Firms are always better off under acquisition than direct entry.*

2.4 Comparison of the R&D investments under direct entry and acquisition

Now, we compare the R&D investments under direct entry and acquisition.

Proposition 2: *(i) Firm 1's R&D investment under acquisition is higher than its own R&D investment under direct entry.*

(ii) Total R&D investment is higher under direct entry than acquisition.

Proof: (i) Comparison of (8) and (19) shows that (19) is always greater than (8).

(ii) Comparison of (9) and (19) shows that (9) is greater than (19) for $\tau > \frac{4}{7}$, which holds always since $\frac{8}{9} > \frac{4}{7}$. Q.E.D.

Since quality of the technology under direct entry depends on the R&D investment of the individual firm, the following corollary is immediate from Proposition 2.

Corollary 1: *Relatively superior technology is always used under acquisition than direct entry.*

The above result is in sharp contrast to Mattoo et al. (forthcoming). Acquisition increases concentration in the product market and also increases profit compared to direct entry. The higher profit under acquisition tends to increase R&D investment. On the other hand, there is a strategic effect under direct entry. Under direct entry, if a firm invests more in R&D, its market share and profit increase. The strategic effect tends to increase R&D investment under direct entry. We find that the effect of market concentration dominates the strategic effect of direct entry and generates higher R&D investment of firm 1 under acquisition than direct entry. However, total R&D investment is higher under direct entry than acquisition.

2.5 Comparison of consumer surplus and social welfare under direct entry and acquisition

Let us now see the effects of different types of FDI on consumer surplus and social welfare of the domestic country.

Proposition 3: *Consumer surplus is higher under direct entry than acquisition.*

Proof: Comparison of (11) and (20) proves the result. Q.E.D.

We have seen that relatively superior technology is used under acquisition, which creates a positive impact on consumer surplus. But, acquisition increases market concentration, which tends to reduce output, and creates a negative impact on consumer surplus. We find that the market concentration effect dominates the technology effect and makes consumers worse-off under acquisition than direct entry. So, if there is possibility of lobbying by consumers or the domestic producer, the domestic government is likely to favor acquisition (direct entry) if the domestic producer (consumers) has more lobbying power.

Propositions 1 and 3 show that there is a conflict between the interests of consumers and domestic producer. Given this conflict, it is interesting to see whether a welfare-maximizing domestic government favors direct entry or acquisition. We find that social welfare of the domestic country under acquisition is

$$W^{aq} = \frac{\tau^2 (a-c)^2}{2(2\tau-1)^2} + F^*. \tag{27}$$

Proposition 4: *If* $\frac{11+\sqrt{41}}{10} > \frac{a}{2c}$, *social welfare of the domestic country is higher under acquisition when the bargaining power of firm 1 (the foreign firm) is sufficiently low and* $\tau \in (Max\{\frac{8}{9}, \frac{a}{2c}\}, \frac{11+\sqrt{41}}{10})$. *Otherwise, social welfare of the domestic country is higher under direct entry.*

Proof: Comparing (14) and (27) we find that if $\alpha = 1$, (14) is always greater than (27). But, if $\alpha = 0$, we find that (27) is greater (less) than (14) if and only if

$$0 > (<) 5\tau^2 - 11\tau + 4. \tag{28}$$

We find that $\tau = \frac{11-\sqrt{41}}{10}$ and $\tau = \frac{11+\sqrt{41}}{10}$ are the roots of the equation $5\tau^2 - 11\tau + 4 = 0$. Since, we consider $\tau > Max\{\frac{8}{9}, \frac{a}{2c}\}$, $\tau = \frac{11+\sqrt{41}}{10}$ is the only feasible root for our analysis. Though $\frac{11+\sqrt{41}}{10}$ is greater than $\frac{8}{9}$, it may or may not be grater than $\frac{a}{2c}$. We also find that $5\tau^2 - 11\tau + 4$ is negative at $\tau = \frac{8}{9}$, and it is continuous and convex in τ for $\tau \geq \frac{8}{9}$. Therefore, if $\frac{11+\sqrt{41}}{10} > \frac{a}{2c}$, (27) is greater than (14) at $\alpha = 0$ for $\tau \in (Max\{\frac{8}{9}, \frac{a}{2c}\}, \frac{11+\sqrt{41}}{10})$.

Since we find from (24) and (27) that social welfare of the domestic country under acquisition is continuous and negatively sloped in $\alpha \in [0,1]$, social welfare is greater under acquisition when α and τ are sufficiently low. Otherwise, (14) is greater than (27) and social welfare is higher under direct entry. Q.E.D.

When τ is low, it reduces the cost of R&D and therefore, increases R&D investment. Further, lower bargaining power of the foreign firm implies that most of the benefit of acquisition is extracted by the domestic firm, which raises domestic

welfare. Combination of these effects creates higher domestic welfare under acquisition than direct entry.

The above proposition shows the importance of the bargaining power and the cost of R&D on domestic welfare. We show that domestic welfare is higher under acquisition only if τ is sufficiently low, which is in stark contrast to Mattoo et al. (forthcoming).

3. Conclusion

We show the implications of R&D and bargaining power of the firms on the preferences of a foreign firm and a host country government for FDI through direct entry and acquisition. We find that relatively superior technology is always used under acquisition and there is a conflict between the interests of consumers and producers. Firms prefer acquisition, whereas consumers prefer direct entry. However, the host country welfare may be higher or lower under acquisition. The host country welfare is higher under acquisition if the bargaining power of the foreign firm and the slope of the marginal cost of R&D are sufficiently low. Otherwise, the host country welfare is higher under direct entry. So, while designing the FDI policies, it is important to consider the bargaining powers and the R&D capabilities of the firms.

References

Barros and, P. and L. Cabral, 1994, 'Merger policies in open economies', *European Economic Review*, **38**: 1041 – 55.

Das, S. and S. Sengupta, 2001, 'Asymmetric information and international mergers', *Journal of Economics and Management Strategy*, **10**: 565 – 90.

Ethier, W. J. and J. R. Markusen, 1996, 'Multinational firms, technology diffusion and trade', *Journal of International Economics*, **41**: 1 – 28.

Ferrett, B., 2003, 'Greenfield investment versus acquisition: positive analysis', *GEP Research Paper, 2003/02*, University of Nottingham.

Head, K. and J. Ries, 1997, 'International mergers and welfare under decentralized competition policy', *Canadian Journal of Economics*, **30**: 1104 – 23.

Horn, H. and J. Levinsohn, 2001, 'Merger polices and trade liberalization', *Economic Journal*, **111**: 244 – 76.

Lee, F. C. and O. Shy, 1992, 'A welfare evaluation of technology transfer to joint ventures in the developing countries', *International trade journal*, **2**: 205 – 20.

Markusen, J. R., 2001, 'Contracts, intellectual property rights, and multinational investment in developing countries', *Journal of International Economics*, **53**: 189 – 204.

Mattoo, A., M. Olarreaga and K. Saggi, forthcoming, 'Mode of foreign entry, technology transfer, and FDI policy', *Journal of Development Economics*.

Mukherjee, A., 2000, 'Host-country policy – commitment or no-commitment: a theoretical analysis', *Journal of Policy Reform*, **4**: 75 – 89.

Mukherjee, A., 2002, 'Subsidy and entry: the role of licensing', *Oxford Economic Papers*, **54**: 160 – 71

Roy, P. T. Kabiraj and A. Mukherjee, 1999, 'Technology transfer, merger, and joint venture: a comparative welfare analysis', *Journal of Economic Integration*, **14**: 442 – 66.

Saggi, K., 1996, 'Entry into a foreign market: foreign direct investment versus licensing', *Review of International Economics*, **4**: 99 – 104.

Saggi, K., 1999, 'Foreign direct investment, licensing and incentives for innovation', *Review of International Economics*, **7**: 699 – 714.