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TRANSFER OR NOT TO TRANSFER THE BEST TECHNOLOGY UNDER THREAT OF ENTRY- THE CASE OF PRICE COMPETITION*

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ABSTRACT:

In this paper we study the possibility of technology transfer from a multinational to a local firm where the transnational corporation is endowed with superior technological capacities. The local firm is protected by a prohibitive tariff which deters entry of the multinational into the local market. The product market is characterised by Bertrand type price game. We show that the ability of the local firm to enter the multinational's existing network of markets in the post-technology transfer situation crucially affects the 'quality' of the transacted technology and the best technology will never feature in such technology trade.

* This is a revised version of our previous work on "International Technology Transfer Under Potential Threat Of Entry- The Case of Price Competition".

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1. Introduction :

The importance of north-south technology transfer is well recognised in the literature on trade and development. One direction of this research has been to probe the hypothesis that the technologically advanced multinations would not in general transfer the most up-to-date knowhow to the backward firms of a typically less-developed country (LDC). The small size of the domestic market or low demand profile and payment constraints imposed by the domestic government are some factors which result in trade in second hand knowhows. (See in Alam (1985), Desai (1988) and Kabiraj (1991)).

This paper seeks to identify a possible alternative cause and addresses to the problem of international technology transfer where potential threat of entry of the technology buyer into the technology seller's existing network of markets determines the quality of the transacted technology. Similar point has been raised in the empirical work of Balasubrahmanyam (1973). In a sense, our paper is a supplement to the micro-economic aspects of the technology transfer problem as relevant to the readers of development economics. It also extends the general literature on industrial organisation in the international context focusing on the inter firm relationship across national boundaries. As it is not easy to punish the late entrants in the international market because of imperfect patent protection and high monitoring cost, it induces firms to adopt certain strategies which they donot have to adopt in a closed economy. An example will clarify the point. Suppose an American MNC operates

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in India and Brazil. If for some reason, Indian firm gets American superior production technology, it can compete with the American firm in the Brazilian market. If the Brazilian government wants competition (there is no reason why it should not) it will allow entry of the Indian firm and the MNC's profit in Brazil will go down. If the MNC could be effectively protected by the patent laws, the latecomer could not enter the parent firm's other markets. Therefore, such potential threat of entry should be an extremely important factor in shaping up the nature of agreement and determining the 'quality' of the transferred technology.

The literature which is in some sense related to our work is as follows. In Gallini (1984) technology licensing is thought to be an alternative strategy to deter R & D of a potential entrant. Kabiraj and Marjit (1990a) have discussed possible licensing equilibria in a duopolistic structure where only latecomer is allowed to do imitative innovations. Katz and Shapiro (1986), Kamien and Tauman (1986) and Muto (1990) have studied the implications of alternative licensing strategies. Rockett (1990a) deals with the problem of choosing right competitors from a set of asymmetric entrants. Gallini and Winter (1985) and Katz and Shapiro (1985) have examined various aspects of licensing and imitation. In Katz and Shapiro (1985) imitation is costless but the licensing game in Gallini and Winter (1985) assumes no imitation. The article by Gallini and Wright (1990) analyses licensing of an innovation in a situation when only the licensor has full private information

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on the value of the innovation, and the transfer of this information facilitates imitation. But the licensor and the licensee donot compete in the same market.

None of the above papers is concerned with the 'quality' of licensing in a situation when the transferor perceives threat of competition from the transferee. The existing literature provides only a very few papers which deal with such a problem. The article by Rockett (1990b) is worthmentioning in this context. Both in Rockett(1990b) and in Kabiraj and Marjit (1990b), output market is characterised by Cournot-Nash competition. In Rockett, both the licensor and the licensee operate in the same market. She has examined the cases when imitation is either not possible or it involves cost. When imitation is not possible, royalty per unit and the 'quality' of the technology are substitute instruments and the best technology is transferred. When imitation is possible, at least partially, the lisensor will adopt two part tariff(fixed fee plus royalty) and the newest innovation will not be transferred. In Kabiraj and Marjit(1990b), by construction, licensing creates competition in seller's market whereas the buyer's market is perfectly protected by prohibitive tariff. The licensee can imitate the technology it gets through license and the imitation is costless. Hence only fixed fee is charged. The paper also provides an example to show that by controlling upfront payments the domestic government can implement the first-best solution where the best technology is transferred and social welfare is maximised.

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Our present paper deals exactly with the same problem but here the product market is characterised by Bertrand type price game. The basic message is that a multinational firm will not transfer its best technology to a firm in a LDC to avoid the fierce competition from the transferee that would result otherwise. However it does not rule out the possibility of 'partial' transfer. For the purpose of our analysis we assume that patent protection is not enforced outside the national boundary and that the LDC government does not permit any restrictive export clauses

The peper is divided into three sections. The second section describes the model and we make concluding remarks in the last section.

2. Model

The scenario of our analysis is as follows. We consider two firms, foreign and domestic, with monopoly of each in its own market, selling homogeneous product. We assume that the size of foreign firm's market is 'no smaller'. This is obvious because by the foreign firm's market we mean the whole network of markets and not necessarily its own domestic market only.

A level of technology is defined to be a constant marginal cost of production so that superior innovations imply lower marginal costs. The foreign and the domestic firms have asymmetric cost structure and in the absence of domestic government's tariff

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protection, the domestic firm will be competed out through price competition. By our construction, each firm has lower (marginal) cost than its rival in its own market. For the foreign firm this is a natural cost advantage, from its superior technology. For the domestic firm, this is the result of a tariff. Because of the cost advantages each firm will either be an unrestricted monopolist[1]- if the cost advantage is great enough - or a limit pricing monopolist[2] in its own market. The result of technology transfer to the foreign firm is to either cause it to limit price where it did not need to before, or to lower its limit price. This is because its cost advantage is eroded. For the domestic firm, the transfer of superior technology increases its profit. If this increase outweighs the profit decrease for the foreign firm, the technology transfer can be mutually benefitial at an appropriate price. Otherwise it cannot.

Let us label ~~to~~ the foregn and the domestic firm as firm I and firmII respectively. Foreign firm is a multinational firm endowed with superior methods of production and domestic firm is a technologically backward firm of a less developed country. The present technology level of firmII is the marginal cost C_2, whereas firmI possesses all the technologies in the closed and continuous interval $S \equiv [C_1, C_2]$ where $C_1 < C_2$, and faces a tariff, T, per unit of output, in LDC market such that $C_1 + T > C_2$. The last inequality is meant to protect the domestic firm from the competition of foreign firm.

Now given C_1, C_2 and T, The foreign firm will be an unrestricted monopolist in its market and will charge a monopoly

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price $P_{m1} \equiv P_m(C_1)$ at C_1 level of technology if $P_{m1} \leq C_2$, otherwise , it will be a limit pricing monopolist with limiting price C_2. Similarly, when $P_{m2} \equiv P_m(C_2) \leq C_1 + T$, the domestic firm will be an unrestricted monopolist in the domestic market where P_{m2} is the monopoly price at C_2 level technology, otherwise it will be a limit pricing monopolist and charge a price $C_1 + T$. Therefore, under Bertrand type price competition, the pretransfer payoffs of firmI and II are respectively $\Pi_1(C_1, C_2)$ and $\Pi_2(C_1 + T, C_2)$, where

$$\Pi_1(C_1, C_2) = [\min(P_{m1}, C_2) - C_1]\, Q[\min(P_{m1}, C_2)]$$

$$\text{and} \quad \Pi_2(C_1+T, C_2) = [\min(P_{m2}, C_1+T) - C_2]\, Q[\min(P_{m2}, C_1+T)] .$$

Let us denote

$$\Pi_1(C_1, C_2) = (P_{m1} - C_1)\, Q(P_{m1}) \equiv \Pi_{m1}(C_1) \quad \text{when } P_{m1} \leq C_2$$

$$\text{and} \quad \Pi_1(C_1, C_2) = (C_2 - C_1)\, Q(C_2) \equiv \hat{\Pi}_{m1}(C_1, C_2) \text{ if } C_2 < P_{m1}.$$

Similarly,

$$\Pi_2(C_1 + T, C_2) = (P_{m2} - C_2)\, Q(P_{m2}) \equiv \Pi_{m2}(C_2) \text{ when } P_{m2} \leq C_1 + T$$

$$\text{and} \quad \Pi_2(C_1 + T, C_2) = (C_1 + T - C_2)\, Q(C_1 + T) \equiv \hat{\Pi}_{m2}(C_1 + T, C_2) \text{ if } C_1 + T < P_{m2}.$$

Given (C_1, C_2, T), we have following four possible cases :

case(i) : $P_{m2} > C_1 + T > C_2 \geq P_{m1} > C_1$

case (ii): $C_1 + T \geq P_{m2} > C_2 \geq P_{m1} > C_1$

case(iii) : $P_{m2} > C_1 + T \geq P_{m1} > C_2 > C_1$

case (iv) : $C_1 + T \geq P_{m2} > P_{m1} > C_2 > C_1$.

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We examine the possibilities of technology transfer from firmI to firmII under each of the above cases. In particular, we prove the following proposition :

<u>Given the threat of entry by the transferee into the transferor's market, the best technology (i.e. C_1) will never be transferred under price competition.</u>

<u>Case</u> (i) : $P_{m2} > C_1+T > C_2 \geqslant P_{m1} > C_1$

Here in the pretransfer situation, firmI will be unrestricted monopolist (as $P_{m1} \leqslant C_2$), but firmII will be a limit pricing monopolist (as $P_{m2} > C_1+T$). So the initial payoffs of the foreign and domestic firms are respectively $\Pi_{m1}(C_1)$ and $\hat{\Pi}_{m2}(C_1+T, C_2)$. Now transfer of a technology $\tilde{C} \in S$ is defined to be feasible if and only if

$$\Pi_2(C_1+T, \tilde{C}) - \hat{\Pi}_{m2}(C_1+T, C_2) > \Pi_{m1}(C_1) - \Pi_1(C_1, \tilde{C}) \quad \ldots\ldots \quad 1(a)$$

$$\text{or} \quad \Pi_2(C_1+T, \tilde{C}) + \Pi_1(C_1, \tilde{C}) > \Pi_{m1}(C_1) + \hat{\Pi}_{m2}(C_1+T, C_2) \quad \ldots\ldots\ldots 1(b)$$

1(a) states that extra profit generated in the domestic market for the use of better technology must be greater than the loss of profit in the foreign market under price competition. Alternatively, 1(b) says that the sum of post-transfer payoffs of the firms must be greater than that in the pretransfer situation. (We denote the left hand side of the condition as LHS(.) and right hand side as RHS(.)).

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Proof of the proposition under case (i)

Under case (i), $\Pi_2(C_1+T, C_1) = \Pi_{m2}(C_1)$ and $\Pi_1(C_1, C_1) = 0$, that is, if firmII gets C_1 technology, it becomes unrestricted monopolist but firmI's profit drops to zero. So when $\tilde{C} = C_1$, LHS(1(b)) $= \Pi_2(C_1+T, C_1) + \Pi_1(C_1, C_1) = \Pi_{m2}(C_1)$, and RHS(1(b)) $= \Pi_{m1}(C_1) + \hat{\Pi}_{m1}(C_1+T, C_2)$. Now the assumption that 'foreign market is no smaller than domestic market' implies $\Pi_{m2}(C_1) \leq \Pi_{m1}(C_1)$. Hence at $\tilde{C} = C_1$, LHS (1(b)) $<$ RHS (1(b)), and transfer of C_1 is not feasible. (QED)

Case (ii) : $C_1+T \geqslant P_{m2} > C_2 \geqslant P_{m1} > C_1$

under case (ii), initial payoffs of the domestic and foreign firms are respectively $\Pi_{m2}(C_2)$ and $\Pi_{m1}(C_1)$, because both are unrestricted monopolists in their own markets. So the feasibility condition of technology transfer will be:

$$\Pi_{m2}(\tilde{C}) - \Pi_{m2}(C_2) > \Pi_{m1}(C_1) - \Pi_1(C_1, \tilde{C}) \quad \ldots \quad 2(a)$$

or $$\Pi_{m2}(\tilde{C}) + \Pi_1(C_1, \tilde{C}) > \Pi_{m1}(C_1) + \Pi_{m2}(C_2) \quad \ldots \quad 2(b)$$

Proof of the proposition under case (ii)

At $\tilde{C} = C_1$, LHS (2(b)) $= \Pi_{m2}(C_1) =$ LHS (1(b)) but RHS (1(b)) $< \Pi_{m1}(C_1) + \Pi_{m2}(C_2) =$ RHS (2(b)), because $\Pi_{m2}(C_2) > \hat{\Pi}_{m2}(C_1+T, C_2)$. Hence the proposition. (QED)

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Case (iii) : $P_{m2} > C_1+T \geqslant P_{m1} > C_2 > C_1$

This is the case where both the domestic and foreign firms are following limiting price strategy in the pretransfer situation and their initial payoffs are $\hat{\Pi}_{m2}(C_1+T, C_2)$ and $\hat{\Pi}_{m1}(C_1, C_2)$ respectively. Then transfer of $\tilde{C}$ could be feasible if and only if

$$\Pi_2(C_1+T, \tilde{C}) - \hat{\Pi}_{m2}(C_1+T, C_2) > \hat{\Pi}_{m1}(C_1, C_2) - \hat{\Pi}_{m1}(C_1, \tilde{C}) \quad \ldots\ 3(a)$$

or $$\Pi_2(C_1+T, \tilde{C}) + \hat{\Pi}_{m1}(C_1, \tilde{C}) > \hat{\Pi}_{m1}(C_1, C_2) + \hat{\Pi}_{m2}(C_1+T, C_2) \quad \ldots\ 3(b)$$

Proof of the proposition under case(iii)

For algebraic simplicity suppose identical market sizes. Let us start from a value of T such that $C_1+T = P_{m1}$. Then under case (iii), at $\tilde{C} = C_1$, we have LHS(3(.))- RHS(3(.)) =

$$\Pi_2(P_{m1}, C_1) - \hat{\Pi}_{m1}(C_1, C_2) - \hat{\Pi}_{m2}(P_{m1}, C_2) = (P_{m1}-C_1)\, Q(P_{m1}) - (C_2-C_1)\, Q(C_2) - (P_{m1}-C_2)\, Q(P_{m1}) = (C_2-C_1)\left[Q(P_{m1}) - Q(C_2)\right] < 0,$$

as $C_2 > C_1$ and $P_{m1} > C_2$. This means transfer of C_1 is not feasible when $C_1+T = P_{m1}$. Now $\hat{\Pi}_{m2}(C_1+T, C_2)$ is an increasing function of C_1+T for $C_2 < C_1+T < P_{m2}$; so $\hat{\Pi}_{m2}(C_1+T, C_2) > \hat{\Pi}_{m2}(P_{m1}, C_2)$ for $P_{m2} > C_1+T > P_{m1}$. Larger size of the foreign market relative to the domestic market will make $\hat{\Pi}_{m1}(C_1, C_2)$ even higher. Hence the proposition. (QED)

Case (iv) : $C_1+T \geqslant P_{m2} > P_{m1} > C_2 > C_1$

Here, in the pretransfer period the foreign firm is a limit pricing monopolist, but the domestic firm has unrestricted

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monopoly. The feasibility condition for transfering a technology $\tilde{c} \in S$ can be written as :

$$\Pi_{m2}(\tilde{c}) - \Pi_{m2}(c_2) > \hat{\Pi}_{m1}(c_1, c_2) - \hat{\Pi}_{m1}(c_1, \tilde{c}) \quad \ldots\ldots \quad 4(a)$$

or

$$\Pi_{m2}(\tilde{c}) + \hat{\Pi}_{m1}(c_1, \tilde{c}) > \hat{\Pi}_{m1}(c_1, c_2) + \Pi_{m2}(c_2) \quad \ldots\ldots \quad 4(b)$$

<u>Proof of the proposition under case (iv)</u> :

Following the proof of the proposition under case (iii) we further note that $\hat{\Pi}_{m2}(c_1+T, c_2) < \Pi_{m2}(c_2)$ for $c_1+T < P_{m2}$, but $\hat{\Pi}_{m2}(c_1+T, c_2) = \Pi_{m2}(c_2)$ when $c_1+T \geq P_{m2}$. Therefore, under case (iv), at $\tilde{c} = c_1$, LHS (4(.)) < RHS (4(.)). (QED)

3. <u>Conclusion</u> :

In this paper we have considered price competition and shown that when the transferor faces potential threat of entry by the transferee into the technology seller's existing network of markets, the best production knowledge will never be transferred. The result is obviously different from that in the quantity-game version of the problem (see in Kabiraj and Marjit (1990b)). This shows that the nature of competition in the output market is important to determine the 'quality' of transferred technology. Although it is not our objective to determine the 'age' of the transferred technology, one can hypothesize that 'partial' transfer may be optimal in such situation. Assuming the case of 'linear' and identical market demand', Kabiraj and Marjit (1990c) have already

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worked out the problem. However, linearity and identical market size is not a restrictive assumption. For example, in the first two cases where foreign firm is unrestricted monopolist, one can easily prove that 'some' transfer is always optimal[3]. The proofs in third and forth cases are, however, subject to some additional assumption.

The paper can be extended in several directions. First of all, this article has overlooked the problems relating to the structure of payments. One can study the role of government policy in affecting the 'quality' of technology transfer in such situations. Second, in characterizing better technologies we have ignored 'scale-effect' altogether. Adaptation cost of an improved innovation might be closely related to the market size of the relevant product, Such issues should feature in the technology agreement between the multinationals and the local partners. Finally, we have not talked about different kinds of entry barriers the local subsidiary can face while trying to penetrate the foreign markets. Such entry barriers might take the form of established brand name of the parent firm, significant entry costs in terms of establishing a network of marketing and distributional facilities etc. This takes us into the question of 'export promotion' and 'technology transfer' as relevant for the developing countries. Recasting the analysis to include the above mentioned cases will definitely lead us to a clearer understanding of issues which have been hitherto neglected in the theoretical literature on international trade and development.

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Note :

1. If two firms, 'i' and 'j', with marginal cost of production C_i and C_j respectively, $C_i < C_j$, compete in a market, and if $P_m(C_i)$ be the monopoly price with C_i marginal cost, then firm 'i' is an unrestricted monopolist if $P_m(C_i) \leq C_j$.

2. When $P_m(C_i) > C_j$, under price competition firm 'i' will charge a price equal to rival's marginal cost C_j, so that firm 'j' cannot make entry with positive profit. Then C_j is the limiting price and firm 'i' is called a limit pricing monopolist.

3. In each of case (i) and (ii), we have proved that at $\tilde{C} = C_1$, LHS < RHS. One can easily notice that for $\tilde{C} \geq P_{m1}$, LHS > RHS; also both sides are continous in $\tilde{C}$. So LHS must intersect RHS at least once for $C_1 < \tilde{C} < P_{m1}$. If there is a single crossing, there exists $\bar{C}$ such that for all $\tilde{C} \in (\bar{C}, C_2)$, LHS > RHS, and these can be potentially transferred. If LHS has multiple crossings with RHS, the feasible set will be disjoint. In any way, the techniques in the neighbourhood of P_{m1} are feasible to transfer and the techniques close to C_1 are not feasible.

References :

1. Alam, Ghayur (1985), "India's Technology Policy and its Influence on Technology Imports and Technology Development", Economic and Political Weekly, Special Number, PP 2073-80.

Contd...P/13

2. Balasubrahmanyam, V.N.(1973), "International Transfer of Technology to India", Praeger, New York.

3. Desai, A.V.(1988), " Technology Acquisition and Application: Interpretations of the Indian Experience", in The Indian Economy, ed. R.E.B. Lucas and G.F. Papanak, Westview Press, Boulder, Colorado.

4. Gallini, N.T.(1984), "Deterrence by Market Sharing : A Strategic Incentive for Licensing", American Economic Review, Vol.74, PP 931-41.

5. Gallini, N.and R.Winter (1985), "Licensing in the Theory of Innovation", Rand Journal of Economics Vol.16,PP 514-26.

6. Gallini, N. and B.Wright (1990), "Technology Transfer under Asymmetric Information",Rand Journal of Economics V.21, PP 147-60.

7. Kabiraj, T. (1991) : "Market size and the Desired Technology Level", Artha Shastra Vol.9, No.2, PP41-47.

8. Kabiraj, T. and S.Marjit(1990a)," Technology Transfer and R & D by the Latecomer -A Strategic Approach", paper prepared for the Volume 'Themes On Economic History and Development - Essays in Memory of Prof.N.Sen', edited by Prof. M.Rakshit.

Contd...P/14

9. Kabiraj, T. and S. Marjit (1990b), "International Technology Transfer under Potential Threat of Entry - A Cournot - Nash Framework", paper presented in the Conference on 'Game Theory and Economic Applications', Indian Statistical Institute, Delhi Centre, December 18-22,1990.

10. Kabiraj, T. and S. Marjit (1990c), " International Technology Transfer under Potential Threat of Entry: The case of Price Competition", paper prepared for the Conference of the Indian Econometric Society,1991.

11. Katz, M. and C. Shapiro (1986), " How to License Intangible Property", Quarterly Journal of Economics, Vol 101, PP 567-89.

12. Katz, M. and C. Shapiro (1985), "On the Licensing of Innovations", Rand Journal of Economics, Vol 16, PP 504-519.

13. Muto, Shigeo (1990), "On Licensing Policies in Bertrand Competition", Discussion Paper No.93, TERG, Tohoku University.

14. Rockett, K. (1990a), "Choosing the Competition and Patent Licensing", Rand Journal of Economics, Vol.21, PP 161-71.

15. Rockett, K. (1990b), "The Quality of Licensed Technology", International Journal of Industrial Organization, Vol.8, PP 559-74.