

# **Strategic Licensing, Exports, FDI and Host Country Welfare**

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**Abstract:** This paper analyses the preference of a foreign firm over serving a host country market and its impact on the welfare of the host country. We show that the foreign firm can choose licensing its superior technology to a host firm strategically which influences the foreign firm's subsequent preference over exporting and FDI. The effect on the host country welfare depends on the structure of the license fee and it is shown that strategic licensing might lead to welfare loss for the host country. To this end this paper also prescribes either an optimal tariff scheme or a ban on licensing to maximize the host country welfare.

**Keywords:** Licensing, exports, FDI, host country welfare.

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# 1. Introduction

Many developing countries (including transition economies) are liberalizing their economies to attract foreign direct investment (FDI), imports and licensing of foreign technology in order to have more competition in their domestic market. Host countries typically associate a range of benefits for such liberalization policies. There exists a large literature on the modes of entry of a foreign firm into a host country. The literature has considered mainly three modes of serving a host country market when a foreign firm has a superior technology as compared to the existing technology of the host firms. The modes include licensing of superior technology to the host firms, exports and foreign direct investment.<sup>1</sup> A foreign firm chooses one of these three modes depending on their relative profitability to serve a particular domestic economy.<sup>2</sup>

However, very little attention has been paid to the interactions between different modes of operation. Saggi (1999) considered a two period model of technology transfer where in each period FDI and licensing are two modes of entry for foreign firm. He focused on the R&D incentives of both foreign and local firms under different entry modes and the technology transfer by the foreign firm. On the other hand, Ethier and Markusen (1996), in their two period product-cycle model, have examined the choice between exporting, licensing and subsidiary as different modes of serving the market of a developing country by an MNC. A wide range of equilibrium outcomes is obtained in their paper including exporting in both periods, exporting in first period followed by licensing in the second period, subsidiary in both periods etc. A key feature of the above two models is that licensing leads to imitation of foreign technology by the local firms.<sup>3</sup> On the contrary, we focus on the post WTO scenario, where imitation possibility is assumed away due to strict compliance of IPR laws. However, in our model the licensing to the host firm occurs in conjunction with FDI or exports and the licensing acts as a strategic instrument for the foreign firm to influence the mode of entry in

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<sup>1</sup> There is another mode, which is the acquisition of the host firm or forming a joint venture with it. However, it is anticompetitive in nature as the market becomes a monopoly. Thus, we ignore this acquisition or joint venture mode.

<sup>2</sup> See among others Dunning, 1981; Ethier, 1986; Markusen, 1984; Helpman, 1984, 1985; Horstmann and Markusen, 1992; Motta, 1992; Buckley and Casson, 1998.

<sup>3</sup> There are some papers which considered the impact of intellectual property rights protection on the choice of entry modes (Markusen, 2001; Fosfuri, 2000; Sinha, 2006 etc.)

its favour.<sup>4</sup> More specifically, we ask whether a foreign firm can gain by using the optimal licensing policy strategically prior to its choice between export and FDI. Does this strategic licensing affects its subsequent entry behaviour in terms of exports and FDI? How does the optimal licensing strategy affect the welfare in the host country? What sort of policy conclusions can be drawn from there?

The purpose of this paper is to show that the foreign firm, with superior technology, would strategically choose licensing prior to its choice of a mode of entry between export and FDI. The optimal licensing involves royalty licensing if the FDI is the equilibrium mode of operation. When exporting is the equilibrium mode choice then the foreign firm's optimal licensing strategy can be fixed fee, royalty or a two part tariff. This strategic licensing of the foreign firm may not serve the best interest of the host country. The welfare effect in the host country depends on the structure of license fee as well as on the mode of operation of the foreign firm. Interestingly, it is found that the welfare in the host country after licensing might decrease if there is a mode switch from FDI to exporting due to licensing and the overall cost efficiency of the industry falls. Under such circumstances, we also provide a new theory of tariff, which would improve the welfare in the host country.

This paper is closely related to Kabiraj and Marjit (2003). They considered a duopoly model where a foreign firm and a local firm compete in a host country and showed that the tariff may induce a technology transfer from foreign firm to the local firm thereby making the consumers better off in the host country. However, our model is very different from their model. First, they consider only fixed fee licensing whereas our optimal licensing scheme involves *two part tariff*. Secondly, in their model the foreign firm exports its product to local market whereas we consider the tradeoff between exporting and FDI and also analyse how the structure of license fee affect these modes of operation of the foreign firm. Thirdly, the technology licensing will always take place in our model. However the role of tariff is to make the license fee favourable to the consumers. In Kabiraj and Marjit, tariff induces technology transfer which otherwise would not happen in equilibrium. Mukherjee and Pennings (2006) further extended Kabiraj and Marjit's model to a situation where the foreign

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<sup>4</sup> There exists a large literature on patent licensing which focuses on the optimal licensing strategy of a patent holding firm e.g., Kamien and Tauman (1986), Kamien, et. al. (1992), Kamien (1992); Katz and Shapiro (1986), Marjit (1990), Poddar and Sinha (2005), Rockett (1990), Wang (1998). Mukherjee (2007) added an open economy context where a foreign firm with superior technology exports its product to a host country and analysed the optimal licensing scheme.

monopolist chooses competition by deciding on whether to license its superior technology to another foreign firm or to a domestic firm and asked how the commitment to tariff policy of the host government affects the licensing decision and the domestic welfare.

The scheme of the paper is as follows. Section 2 describes the basic model and analyses the benchmark case of royalty licensing. The optimal licensing is studied in Section 3. Section 4 discusses the welfare implications of our model. Section 5 concludes.

## 2. The Basic Model

Consider that there are two firms one host firm and one foreign firm which can serve a host country market. We assume that the inverse demand function in the host country is given by  $p = a - Q$ , where  $p$  is the price of the product,  $a$  is the positive demand intercept and  $Q$  is the total industry output. We assume that the technologies of the two firms are different and the foreign firm has a superior technology as compared to the technology of the host firm. We refer the foreign firm as firm 1 and the host firm as firm 2 hereafter. We assume that the marginal cost of firm 2 is  $c$  and the marginal cost of firm 1 with superior technology is  $c - \varepsilon$  (where  $c > \varepsilon > 0$ ). There are costs associated with the different modes of serving the host market for firm 1. In case of FDI, firm 1 sets up a subsidiary in the host country and the setup cost of a subsidiary is assumed to be  $F > 0$ . In case firm 1 decides to export the product from the production facility located in another country, there is a transport cost  $t$  per unit of output, which the firm 1 has to incur in addition to the cost of production of the good to sell it to the concerned host country. The presence of tariff (if any) can also be incorporated with the transport cost and the combined cost may be treated as  $t$  per unit of output.

We assume away any direct cost associated with the transferring technology under licensing.<sup>5</sup> We consider a situation that firm 1 cannot commit to firm 2 that it would not enter the domestic economy after the licensing contract is signed. This commitment is more of a problem in the present context, as the host government may not like to enforce such a licensing contract, which prevents further entry by firm 1. Suppose, on the contrary, the firm 1 cannot enter the host market after acceptance of the licensing contract under a contract

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<sup>5</sup> In case of licensing, the literature has considered the cost of transferring a technology, associated training costs for using that technology, risk of dissipation of the proprietary knowledge etc. (Teece (1977)).

clause. Then, by licensing the technology to firm 2, the host market can be served under monopoly leading to the maximum producer surplus. This monopoly profit can be divided between the two firms depending on their bargaining power. We assume that the firm 1 has the full bargaining power. As a result, the licensing contract will be signed such that firm 2 receives what it can receive in case of no licensing and the market is served under duopoly where firm 1 chooses either export or FDI. In any case, the welfare in the host country depends on the consumer surplus and host producer's surplus. The welfare maximising host government would not like to enforce such a contract, which leads to monopoly in the domestic economy. Thus, the government would not enforce such licensing contract with commitment. When the commitment is absent then firm 1 can choose between export and FDI even after signing the licensing contract with the host firm if the associated setup cost of a subsidiary or the transport costs is not prohibitive to do so. Under such circumstances, we develop a theory of strategic licensing where firm 1 offers a licensing contract, which might change its subsequent entry mode of exports or FDI.

We consider the following two stage game.

**Stage 1.** Firm 1 offers firm 2 a licensing contract with a two part tariff i.e., a fixed fee plus a per unit royalty rate. Firm 2 either accepts or rejects the licensing offer.

**Stage 2.** Firm 1 decides either to enter the host market through FDI or to export to the host market from a foreign location. Finally, both firms compete in a Cournot duopoly market and the payoffs are realized.

We would solve the game by using the standard backward induction argument. First, we consider the payoffs of firm 1 when the licensing offer is rejected. For our purpose, we ignore monopoly outcome in the host country and restrict the parameter ranges such that firm 1 and firm 2 can always produce positive outputs and receive positive profits. Note that firm 2's marginal cost of production is  $c$ . Though firm 1 has a superior technology as compared to firm 2, but we assume that the technology gap is not large enough. As a result, the monopoly outcome of firm 1 in the host country is ruled out. When firm 1 chooses FDI as mode of operation, it would have marginal cost  $c - \varepsilon$  and firm 2 with marginal cost  $c$  can compete with firm 1 and earns a positive profit. This leads us to assume

**A1.**  $a - c > \varepsilon$ .

We make another two assumptions on the range of parameters  $F$  and  $t$ . We assume that firm 1's duopoly profits under exporting and FDI are positive even if firm 2 is licensed under fixed fee. Formally, we assume

**A2.**  $t < \frac{(a - c + \varepsilon)}{2}$  and

**A3.**  $\frac{(a - c + \varepsilon)^2}{9} > F$ .

Hence, both modes of entry are always feasible.

Thus, there can be two forms of duopoly: (i) firm 2 competes with firm 1 under FDI and (ii) firm 2 competes with firm 1 under exporting. Note that firm 1 has the marginal cost  $(c - \varepsilon)$  under FDI and  $(c - \varepsilon + t)$  under exporting and firm 2 has the marginal cost  $c$ . Thus, after rejection of the licensing offer, the payoff to firm 1 under FDI would be given by the duopoly profit

$$\Pi_1^{FDI} = \frac{(a - 2c + 2\varepsilon + c)^2}{9} - F = \frac{(a - c + 2\varepsilon)^2}{9} - F \quad (1)$$

On the other hand, under exporting the profit earned by firm 1 is given by

$$\Pi_1^{Ex} = \frac{(a - 2c + 2\varepsilon - 2t + c)^2}{9} = \frac{(a - c + 2\varepsilon - 2t)^2}{9} \quad (2)$$

Given  $c$ ,  $\varepsilon$  and  $t$ , there exists a unique level of  $F$ , say  $F^*$  at which firm 1 is indifferent between exporting and FDI. Hence, by (1) and (2)

$$F^* = \frac{(a - c + 2\varepsilon)^2}{9} - \frac{(a - c + 2\varepsilon - 2t)^2}{9} > 0$$

If  $F < F^*$ , firm 1 will prefer FDI to exporting and for  $F \geq F^*$  (satisfying A3), firm 1 prefers exporting to FDI.

Thus, given the mode choice of firm 1, firm 2's payoff under no licensing (NL) would be

$$\Pi_2^{NL} = \begin{cases} \frac{(a - c - \varepsilon)^2}{9} & \text{if } F < F^* \\ \frac{(a - c - \varepsilon + t)^2}{9} & \text{if } F \geq F^* \end{cases} \quad (3)$$

Given the structure of the game, firm 2 would accept the licensing offer if firm 2 receives at least the above payoffs in subsequent equilibrium.

## 2.1. Benchmark Case: Royalty licensing

First, we consider a feasible licensing strategy, which establishes that licensing is a better strategy than no licensing. To do that we consider only royalty licensing method where firm 1 licenses its superior technology at a per unit output royalty rate  $r$  and the amount of royalty firm 2 pays will depend on the quantity firm 2 will produce using the new technology. We focus on the royalty licensing with  $r = \varepsilon$ . In this case firm 2's effective per unit marginal cost remains unchanged as the royalty rate to be paid per unit of output is just equal to the amount of cost saving from licensing. However, firm 1 receives  $\varepsilon$  amount per unit output produced by firm 2. We would show that firm 2 accepts this contract, as it does not make firm 2 worse off. By this royalty licensing firm 1 receives royalty revenue and also the duopoly profit either from exporting or FDI.

Suppose that FDI would be chosen after licensing under royalty. Then firm 1 would have marginal cost  $c - \varepsilon$  and firm 2 has the effective marginal cost  $c$  (same as without licensing). Thus, the total payoff obtained by firm 1 under royalty licensing and subsequent FDI is given below.

$$\Pi_1^{FDI}(r = \varepsilon) = \frac{(a - c + 2\varepsilon)^2}{9} - F + \varepsilon \left\{ \frac{(a - c - \varepsilon)}{3} \right\}. \quad (4)$$

On the other hand, suppose firm 1 chooses to export after licensing the technology at a royalty  $r = \varepsilon$ . Then the post licensing payoff to firm 1 under export would be

$$\Pi_1^{EX}(r = \varepsilon) = \frac{(a - c + 2\varepsilon - 2t)^2}{9} + \varepsilon \left\{ \frac{(a - c - \varepsilon + t)}{3} \right\} \quad (5)$$

By comparing the payoffs of firm 1 under no licensing and royalty licensing (see (1), (2), (4) and (5)), it is clear that with royalty licensing  $r = \varepsilon$ , firm 1 obtains more payoffs both under exporting and FDI as compared to the situation when licensing does not take place. Observe that firm 1 receives royalty revenue as an extra payment for licensing its superior technology even though its profits under both modes remain the same as they were under no licensing. Thus, firm 1's strategy of licensing the technology with  $r = \varepsilon$  is better than no licensing.

Now under royalty licensing with  $r = \varepsilon$  firm 1 chooses to export as opposed to FDI if

$$F \geq F^* - \varepsilon \left( \frac{(a - c - \varepsilon + t)}{3} - \frac{(a - c - \varepsilon)}{3} \right) = F^* - \varepsilon \left( \frac{t}{3} \right) = F'' \text{ (say)}. \quad (6)$$

Since  $\varepsilon\left(\frac{t}{3}\right) > 0$ , we have

**Lemma 1.**  $F^* > F''$

Thus, in the presence of licensing firm 1 switches mode from FDI to export for  $F \in [F'', F^*)$ . Due to the change of mode as a result of licensing, firm 2's payoff would be affected in the following way. Both for  $F < F''$  and for  $F \geq F^*$ , the payoffs to firm 2 would remain the same as it was without licensing. However, for  $F \in [F'', F^*)$  firm 2 would be producing more post licensing when firm 1 chooses to export after licensing as compared to the situation when firm 1 chooses FDI without licensing. This happens because of the choice of export post licensing where firm 1 would operate with a higher marginal cost leaving more space in the market for firm 2 to produce more. As a result of this higher production by firm 2, the profit of the firm 2 would be higher for this range of  $F$ , though it does not enjoy any effective advantage in the cost structure post licensing. Therefore, firm 2 would always accept the licensing contract with  $r = \varepsilon$ .

### 3. Optimal licensing strategy

We have seen in the previous section that by using the royalty licensing firm 1 can strategically influence its entry mode into the host country. Here we determine the optimal licensing strategy of firm 1. Let us now consider the general licensing scheme involving both fixed fee ( $f$ ) and a linear royalty ( $r$ ) per unit of output (i.e., as two part tariff). We impose the natural restrictions that  $f, r \geq 0$ . Note that only fixed fee and only royalty are two special cases of a general two part tariff licensing scheme. Given the structure of the game, two types of equilibrium outcomes are possible post licensing: one in which FDI is the equilibrium and the other in which exporting is the equilibrium mode for firm 1 to serve the host market. Note that the optimal licensing scheme would definitely generate a (weakly) greater payoff for firm 1 than only royalty licensing considered in the benchmark case. In the following analysis we would first show in proposition 1 that whenever FDI is the equilibrium mode post licensing, the firm 1's optimal licensing strategy involves only royalty payment (and no fixed fee). Then we establish that when export is the equilibrium mode, the optimal licensing strategy involves either fixed fee or royalty or a two part tariff (propositions 2 and 3). Thus,

in comparison to the benchmark case, there would be no change in optimal payoff for firm 1 if FDI is the equilibrium mode post licensing. On the other hand, if the export is the equilibrium mode post licensing then the payoff to firm 1 would be weakly greater as compared to the benchmark case. Finally, the payoffs are compared and the equilibrium mode choice is characterized in proposition 4. Now we consider the case of FDI option post licensing.

### Case 1. FDI post licensing

We consider that firm 1 can choose a combination of fixed fee and royalty  $(f, r)$  to license the technology. Suppose firm 1 plans to choose FDI option in the stage 2 of the game after acceptance of the licensing offer in the first stage. To determine the optimal licensing strategy and the associated payoff from FDI, first observe that after *rejection* of the licensing contract there would be duopoly competition where firm 1 would either export or do FDI depending on  $F^*$ . As a result, the acceptable licensing contract must provide the reservation payoff to firm 2, which is given by  $\Pi_2^{NL}$  in (3) and dependent on  $F^*$ .

Thus, firm 1 should choose  $(f, r)$  such that firm 2 receives at least the payoff  $\Pi_2^{NL}$  (under subsequent FDI). Suppose firm 2 accepts the licensing contract. After accepting the licensing contract firm 2 receives  $\frac{(a-c+\varepsilon-2r)^2}{9} - f$ . Thus, firm 2 would accept the licensing offer

if the amount of fixed fee  $f$  for any given  $r$  is at most

$$f = \frac{(a-c+\varepsilon-2r)^2}{9} - \Pi_2^{NL}. \quad (7)$$

The firm 1's payoff under this licensing contract would be its own profit in the product market due to competition *plus* the fixed fee it charges and the royalty revenue it receives and minus the fixed cost of FDI.

Thus, firm 1's total payoff is

$$\pi_1^{FDI}(f, r) = \frac{(a-c+\varepsilon+r)^2}{9} - F + f + r \frac{(a-c+\varepsilon-2r)}{3} \quad (8)$$

Using the value of  $f$  from (7), the unconstrained maximization with respect to  $r$  of the above payoff function yields

$$r = \frac{(a-c+\varepsilon)}{2}. \quad (9)$$

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<sup>6</sup> Note that  $\Pi_2^{NL}$  does not depend on  $r$ .

Thus,  $r > \varepsilon$  (by Assumption A1). Now we have two cases to consider. When  $F < F^*$ , then given the reservation payoff of firm 2 from (3), with  $r > \varepsilon$ , the value of fixed fee (from (7)) would be negative. So  $r > \varepsilon$  is ruled out. Thus, given the concavity of firm 1's profit function the optimal royalty would be  $r^* = \varepsilon$ . Hence, the optimal fixed fee would be zero.

On the other hand, when  $F \geq F^*$ , then given the reservation payoff of firm 2 from (3), we find that even with  $r = \varepsilon$ , the amount of fixed fee from (7) is negative. Thus, in order to make the licensing contract acceptable to the firm 2 the royalty rate  $r$  is to be even lower than  $\varepsilon$ . Without getting into determining the optimal royalty rate in case of  $F \geq F^*$ , it is easy to see that the payoff to firm 1 would be less than exporting option with  $r = \varepsilon$  (follows from the benchmark case). Thus, FDI option cannot occur in equilibrium for  $F \geq F^*$ .

However, for the case  $F < F^*$ , the licensing with royalty  $r^* = \varepsilon$  would be accepted by firm 2 as firm 2 is indifferent between acceptance and rejection. Thus, for  $F < F^*$  we find that when FDI is chosen post licensing then the optimal licensing policy involves only royalty and no fixed fee.

Thus, the payoff to firm 1 from licensing and subsequent FDI would be

$$\frac{(a - c + 2\varepsilon)^2}{9} - F + \varepsilon \left( \frac{(a - c - \varepsilon)}{3} \right). \quad (10)$$

Hence, for  $F < F^*$ , from FDI option along with the optimal licensing strategy firm 1 receives the payoff that is the same as in the benchmark case. We have already seen in the benchmark case that the payoff from export with only royalty licensing dominates the payoff from FDI option with only royalty licensing for  $F \geq F''$ . Thus, FDI cannot be a chosen mode in equilibrium also for the values of  $F^* > F \geq F''$  under the optimal licensing scheme. Thus, FDI can at best arise in equilibrium only for a subset of values of  $F < F''$ . Hence,

**Proposition 1:** *For  $F < F''$ , whenever FDI would be the mode choice post licensing then the optimal licensing strategy for firm 1 is to choose royalty  $r^* = \varepsilon$  and  $f = 0$ . The total payoff to*

*firm 1 is given by  $\frac{(a - c + 2\varepsilon)^2}{9} - F + \varepsilon \left( \frac{(a - c - \varepsilon)}{3} \right)$ .*

We would like to clarify at this stage that the proposition 1 does not imply that FDI would be equilibrium for all values of  $F < F''$ . It only states that for a subset of values of  $F \in (0, F'')$  when FDI is chosen to be the equilibrium mode post licensing then the optimal licensing strategy and the associated payoff to firm 1 are given as above. We will determine the

equilibrium mode choice of firm 1 in proposition 4. For that we need to determine the payoff from the exporting option to which we now turn.

### Case 2. Export option post licencing

Suppose, firm 1 chooses export post licensing. To determine the optimal licensing strategy and the associated payoff from exporting, observe that the acceptable licensing contract must provide the reservation payoff to firm 2, which is given by (3) and dependent on  $F^*$ . Thus, we have two scenarios to consider. Scenario 1 where FDI is the equilibrium mode after rejection of the licensing offer i.e., when  $F < F^*$  and Scenario 2 where export is the equilibrium mode after rejection for  $F \geq F^*$ .

#### Scenario 1. $F < F^*$

Since FDI is the equilibrium after rejection of the licensing offer, firm 1 should choose  $(f, r)$  such that firm 2 receives at least the payoff  $\frac{(a-c-\varepsilon)^2}{9}$  (from (3)).

Suppose firm 2 accepts the licensing contract. After accepting the licensing contract firm 2 receives  $\frac{(a-c+\varepsilon-2r+t)^2}{9} - f$ . Thus, firm 2 would accept the licensing offer if the amount of fixed fee  $f$  for any given  $r$  is at most

$$f = \frac{(a-c+\varepsilon-2r+t)^2}{9} - \frac{(a-c-\varepsilon)^2}{9}. \quad (11)$$

So firm 1 can at the most charge this  $f$  as fixed fee.

Firm 1's payoff under this licensing contract would be its own profit in the product market due to competition *plus* the fixed fee and the royalty revenue it receives.

Thus, firm 1's total payoff is

$$\pi_1^{Ex}(f, r) = \frac{(a-c+\varepsilon-2r+t)^2}{9} + f + r \frac{(a-c+\varepsilon-2r+t)}{3} \quad (12)$$

Using the value of  $f$  from (11) the unconstrained maximization of (12) with respect to  $r$  yields  $r = \frac{(a-c+\varepsilon-5t)}{2}$ . (13)

Now depending on the parameter configurations we have the following four distinct possibilities. If  $r \leq 0$ , only fixed fee would be charged taking  $r = 0$  in (11). If  $0 < r \leq \varepsilon$ , then

optimal royalty is  $r^*$  given by (13) and  $f^*$  given by (11). When  $\varepsilon + \frac{t}{2} > r^* > \varepsilon$ , then  $f > 0$ . The

last possibility is  $r^* = \varepsilon + \frac{t}{2}$  then  $f = 0$ .

Formally,

**Proposition 2:** For  $F < F^*$ , whenever exporting would be the equilibrium post licensing then the optimal licensing strategy for firm 1 is given as:

for  $t \geq \frac{(a-c+\varepsilon)}{5}$ , only fixed fee is charged and  $f = \frac{(a-c+\varepsilon+t)^2}{9} - \frac{(a-c-\varepsilon)^2}{9}$ ;

for,  $\frac{(a-c+\varepsilon)}{5} > t \geq \frac{(a-c-\varepsilon)}{5}$ ,  $0 < r^* \leq \varepsilon$  and  $f^* > 0$  and given by (13) and (11);

for  $\frac{(a-c-\varepsilon)}{5} > t > \frac{(a-c-\varepsilon)}{6}$ ,  $\varepsilon + \frac{t}{2} > r^* > \varepsilon$  and  $f^* > 0$  given by (13) and (11);

and for  $\frac{(a-c-\varepsilon)}{6} \geq t$ ,  $r^* = \varepsilon + \frac{t}{2}$  and  $f^* = 0$ .

It is interesting to note that the optimal royalty is even greater than the amount of cost reduction ( $\varepsilon$ ). This is because for this parameter range FDI would be chosen if the licensing offer is rejected. Given that possibility, firm 1 is able to charge more from licensing its technology as compared to the situation where firm 1 would choose export (which means higher marginal cost for itself) after the rejection of the licensing contract.

Note that when fixed fee is charged and export is the equilibrium the optimal fixed fee is given by  $(2a-2c+t)(2\varepsilon+t)$  (from (11)) and in case of only royalty the optimal royalty is  $r^* = \varepsilon + \frac{t}{2}$ . Thus, the payoff for different values of  $t$  under export with the help of (11) and

(13) is given by

$$\begin{aligned} \pi_1^{Ex}(f, r) = & \\ & \frac{(a-c+\varepsilon-2t)^2}{9} + (2a-2c+t)(2\varepsilon+t) \text{ for } \frac{(a-c+\varepsilon)}{2} > t \geq \frac{(a-c+\varepsilon)}{5}, \\ & \frac{(a-c+\varepsilon-2t+r^*)^2}{9} + f^* + \frac{(a-c+\varepsilon+2r^*+t)}{3} r^* \text{ for } \frac{(a-c+\varepsilon)}{5} > t > \frac{(a-c-\varepsilon)}{6}, \\ & \frac{(a-c+2\varepsilon-\frac{3}{2}t)^2}{9} + \frac{(a-c-\varepsilon)}{3} (\varepsilon + \frac{t}{2}) \text{ for } \frac{(a-c-\varepsilon)}{6} \geq t. \end{aligned} \quad (14)$$

In the intermediate case the values of  $r^*$  and  $f^*$  are both positive and given by (13) and (11) respectively. First note that the royalty rate  $r = \varepsilon$  is a feasible choice. Thus, in scenario 1 under the above optimal licensing scheme, the payoff from export is strictly greater than the payoff obtained under export with  $r = \varepsilon$ .

**Scenario 2.  $F \geq F^*$**

Since export is the equilibrium mode after rejection of the licensing offer, firm 1 should choose  $(f, r)$  such that firm 2 receives at least the payoff  $\frac{(a - c - \varepsilon + t)^2}{9}$  (from (3)).

Suppose, firm 2 accepts the licensing contract. After accepting the licensing contract firm 2 receives  $\frac{(a - c + \varepsilon - 2r + t)^2}{9} - f$ . Therefore, firm 2 would accept the licensing offer if the amount of fixed fee  $f$  for any given  $r$  is at most

$$f = \frac{(a - c + \varepsilon - 2r + t)^2}{9} - \frac{(a - c - \varepsilon + t)^2}{9}. \quad (15)$$

So firm 1 can at the most charge this  $f$  as fixed fee. Now firm 1's payoff function under the exporting option would be similar to (12) with  $f$  being replaced by (15). Note that the difference between (11) and (15) is in their second terms. They are both constant in relation to royalty rate  $r$ . Thus, the routine calculation would show the following optimal licensing policy (by using (13) and (15)).

**Proposition 3:** For  $F \geq F^*$ , whenever export would be the equilibrium post licensing then the optimal licensing strategy for firm 1 is given as:

$$\text{for } t \geq \frac{(a - c + \varepsilon)}{5}, \text{ only fixed fee is charged and } f = \frac{(a - c + \varepsilon + t)^2}{9} - \frac{(a - c - \varepsilon + t)^2}{9};$$

$$\text{for, } \frac{(a - c + \varepsilon)}{5} > t \geq \frac{(a - c - \varepsilon)}{5}, r^* < \varepsilon \text{ and } f^* > 0 \text{ and given by (13) and (15);}$$

$$\text{and for } \frac{(a - c - \varepsilon)}{5} \geq t, r^* = \varepsilon \text{ and } f^* = 0.$$

Thus, the optimal payoff for firm 1 would be as characterized below.

$$\pi_1^{Ex}(f, r) =$$

$$\frac{(a - c + \varepsilon - 2t)^2}{9} + (2a - 2c + 2t)(2\varepsilon) \text{ for } \frac{(a - c + \varepsilon)}{2} > t \geq \frac{(a - c + \varepsilon)}{5},$$

$$\frac{(a-c+\varepsilon-2t+r^*)^2}{9} + f^* + \frac{(a-c+\varepsilon+2r^*+t)}{3} r^* \quad \text{for } \frac{(a-c+\varepsilon)}{5} > t \geq \frac{(a-c-\varepsilon)}{5},$$

$$\frac{(a-c+2\varepsilon-2t)^2}{9} + \frac{(a-c-\varepsilon+t)}{3} \varepsilon \quad \text{for } \frac{(a-c-\varepsilon)}{5} > t. \quad (16)$$

In the intermediate case, the values of  $f^*$  and  $r^*$  are obtained from (15) and (13) respectively.

Having characterized the payoffs for both scenarios under exporting option, now we can analyse the choice of equilibrium mode for firm 1. First note that under export equilibrium the royalty rate  $r = \varepsilon$  is a feasible choice. Therefore, under the optimal licensing scheme the payoff from exporting is weakly greater than the payoff obtained under export with  $r = \varepsilon$  for both scenarios.<sup>7</sup> We have already established in proposition 1 that the payoff to firm 1 under the optimal licensing and subsequent FDI is as given in the benchmark case and the FDI equilibrium can occur only for a subset of values of  $F < F''$ . By comparing the payoffs from both options under scenario 1 we find the choice of parameter ranges for which export and FDI are chosen post licensing. Thus, exporting is preferred over FDI if  $F \geq \bar{F}$  where  $\bar{F} < F''$ . This is because in scenario 1 under the optimal licensing the payoff from exporting is strictly greater than the payoff from exporting with only royalty licensing. Thus, due to the strategic use of licensing firm 1 switches mode to exporting for  $[ \bar{F}, F^* )$  and for  $F < \bar{F}$ , FDI remains to be equilibrium choice even after licensing. Also observe that the optimal licensing fee (fixed fee, royalty or two part tariff) determines the value of  $\bar{F}$ , leading to a range of  $F \in [ \bar{F}, F^* )$  for which the mode switching takes place in favour of exporting due to licensing. Thus, we have

**Proposition 4:** *Firm 1 would license the technology to firm 2. Firm 1 chooses FDI post licensing for  $F < \bar{F}$  and firm 1 chooses exporting post licensing for  $F \geq \bar{F}$ . Thus, there is a mode switch for  $F \in [ \bar{F}, F^* )$  from FDI to exporting due to strategic use of licensing.*

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<sup>7</sup> The payoffs are equal only when  $r = \varepsilon$  for  $\frac{(a-c-\varepsilon)}{5} \geq t$  under scenario 2.

Note that the optimal licensing policy for  $F \in [\bar{F}, F^*)$  and for  $F \geq F^*$  are obtained from Propositions 2 and 3. Before ending this section it should be clarified that the parameter configurations in propositions 2 and 3 are consistent. Note that the parameter values of our model are restricted by our assumptions A1, A2 and A3. Given these restrictions  $F^*$ , which is a function of  $a, c, \varepsilon$  and  $t$ , is always positive. Now propositions 2 and 3 characterise the optimal licensing under exporting option for different values of  $F$  with respect to  $F^*$ . Assumption A2 puts an upper limit on the value of  $t$ . For different values of  $t$  (within the upper limit) and  $F$ , propositions 2 and 3 characterise the optimal licensing strategy under exporting option. In other words, given the parameters,  $F^*$  is uniquely defined. Now the actual  $F$  can be either smaller or greater than  $F^*$ . Given the upper limit on  $t$  by assumption A2,  $t$  would satisfy either of the conditions with respect to  $a, c$  and  $\varepsilon$ , which would fix the optimal licensing strategy.

#### **4. Welfare implication**

It is clear from the above discussion that firm 1 influences its entry mode by strategic licensing in favour of exporting. Whether this switch of mode to export option is detrimental to the welfare of the host country depends on what happens to the equilibrium price in the host market. For a linear demand function as considered here, one can easily check that under Cournot competition, the market price depends on the sum of marginal costs of two firms and as the sum of two marginal costs increases, price increases and vice versa. The consumer surplus is inversely related to the equilibrium price in the market. Also note that the firm 1 charges the optimal licensing fee such that firm 2 receives the same payoff in equilibrium as it would get under different modes without licensing. Therefore, there is no change in producer's surplus for the host country. Thus, the change in consumers surplus is the sole determinant of the change in welfare. For  $F < \bar{F}$  the equilibrium mode choice is FDI and this remains unaffected even after licensing. Here the optimal licensing involves an amount of royalty, which is equal to the cost reduction  $\varepsilon$ . Thus, the marginal costs of firm 1 and firm 2 remain the same even after licensing. As a result the consumer surplus in the host country remains the same. Hence, there is no change in welfare of the host country.

For  $F \in [\bar{F}, F^*)$ , firm 1 serves the host market by doing FDI when the technology is not licensed, but it serves the host country through exports when it chooses to license the technology. Thus, without licensing, the sum of marginal costs in the industry is  $(c - \varepsilon + c) = 2c - \varepsilon$  and after licensing the technology and subsequent switching of the mode to exporting, the sum of marginal costs in the industry depends on the structure of license fee. From proposition 2 we find that for  $\frac{(a - c - \varepsilon)}{5} > t$ , the optimal licensing policy involves a royalty rate  $r^* > \varepsilon$ , the sum of marginal costs in the industry would be  $(c - \varepsilon + t) + (c - \varepsilon + r^*) = 2c - 2\varepsilon + t + r^*$ . So the welfare in the host market would be less due to strategic licensing and the induced change in the mode to export as  $t > 0$  by assumption. Consider  $\frac{(a - c + \varepsilon)}{5} > t \geq \frac{(a - c - \varepsilon)}{5}$ , then  $r^* < \varepsilon$  and  $f > 0$ . Thus, the welfare would be higher post licensing if  $t < \varepsilon - r^*$ ; but the welfare would be lower post licensing if  $t \geq \varepsilon - r^*$ . Using the value of  $r^*$  from (13), it is clear that the welfare in the host country falls for  $\frac{(a - c - \varepsilon)}{3} > t \geq \frac{(a - c - \varepsilon)}{5}$  and the welfare goes up for  $\frac{(a - c + \varepsilon)}{5} > t \geq \frac{(a - c - \varepsilon)}{3}$  provided that  $\varepsilon > \frac{(a - c)}{4}$ . However, when  $\varepsilon \leq \frac{(a - c)}{4}$ , the welfare in the host country falls for  $\frac{(a - c + \varepsilon)}{5} > t \geq \frac{(a - c - \varepsilon)}{5}$ . Now consider the case  $t \geq \frac{(a - c + \varepsilon)}{5}$ . Here, only fixed fee is charged, and then the sum of marginal costs in the domestic industry becomes  $(c - \varepsilon + t) + (c - \varepsilon) = 2c - 2\varepsilon + t$ . The welfare in this case would be higher if  $t < \varepsilon$ ; but the welfare would be lower post licensing if  $t \geq \varepsilon$ . It is also clear from the above discussion that for larger markets (with higher demand intercept  $a$  here) the switch of mode from FDI to exporting due to strategic use of licensing is always welfare reducing.<sup>8</sup>

Now consider the possibility  $F > F^*$ . Firm 1 serves the host market under exporting both pre- and post licensing situations. Thus, without licensing the sum of marginal costs in the industry is  $(c - \varepsilon + t) + c = 2c - \varepsilon + t$  and after licensing the technology, the sum of marginal

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<sup>8</sup> Interestingly, note that an increase in the market size increases the likelihood that the welfare would go down, which follows from the fact that  $r^*$  is a positive function of  $a$ .

costs in the industry depends on the structure of license fee. For  $\frac{(a-c-\varepsilon)}{5} \geq t$ , only royalty licensing is optimal and the sum of marginal costs in the industry would be  $c - \varepsilon + t + c$  and hence there would be no change in welfare. For  $\frac{(a-c+\varepsilon)}{5} > t \geq \frac{(a-c-\varepsilon)}{5}$ , both fixed fee and royalty is charged and the sum of marginal costs in the industry would be  $(c - \varepsilon + t) + (c - \varepsilon + r^*) = 2c - 2\varepsilon + t + r^*$ . Since  $r^* < \varepsilon$ , the welfare would be higher post licensing. For  $t \geq \frac{(a-c+\varepsilon)}{5}$ , only fixed fee is charged and the sum of marginal costs in the domestic industry becomes  $(c - \varepsilon + t) + (c - \varepsilon) = 2c - 2\varepsilon + t$ . The welfare in this case would be higher too. Thus, when the exporting remains as the optimal mode both in pre- and post licensing stage, then if  $r^* = \varepsilon$ , the host country welfare remains the same; and if  $r^* < \varepsilon$  then the welfare in the host country increases post licensing.

Now we summarise the results on welfare due to strategic licensing by firm 1 as compared to the situation with no licensing.

**Proposition 5:** (a) Suppose  $F < \bar{F}$ , the welfare in the host country remains unaffected even after licensing.

(b) Suppose  $F \in [\bar{F}, F^*)$ , then

(i) For  $\frac{(a-c-\varepsilon)}{5} > t$ , firm 1 uses strategic licensing leading to a mode switching for firm 1 from FDI to exporting and as a result the welfare in the host country falls.

(ii) For  $\frac{(a-c+\varepsilon)}{5} > t \geq \frac{(a-c-\varepsilon)}{5}$ , two situations arise. If  $\varepsilon > \frac{(a-c)}{4}$ , then the welfare in the host country falls for  $\frac{(a-c-\varepsilon)}{3} > t \geq \frac{(a-c-\varepsilon)}{5}$  and the welfare goes up for  $\frac{(a-c+\varepsilon)}{5} > t \geq \frac{(a-c-\varepsilon)}{3}$ . However, if  $\varepsilon \leq \frac{(a-c)}{4}$ , the welfare would always be lower post licensing.

(iii) For  $t \geq \frac{(a-c+\varepsilon)}{5}$ , the welfare in this case would be higher if  $t < \varepsilon$ ; but the welfare would be lower post licensing if  $t \geq \varepsilon$ .

(c) For  $F \geq F^*$ , the welfare in the host country either increases or remains the same post licensing.

When the strategic licensing by the foreign firm leads to no change of modes, then under either form of duopoly (exporting or FDI) the licensing of foreign technology either does not affect the host country welfare or it actually increases the welfare. The welfare in the host country remains unaffected when the foreign firm either sticks to its option of FDI or exporting both in pre- and post licensing along with the optimal licensing policy being royalty ( $r^* = \varepsilon$ ) for the foreign firm. On the other hand, the licensing increases welfare in the post licensing stage when the optimal licensing policy under exporting involves the optimal royalty to be  $r^* < \varepsilon$ . However, the licensing may reduce welfare in the host country when the foreign firm switches mode of operation from FDI to exporting. The reason for our result stems from the fact that there is a change in foreign firm's production strategy from FDI to exporting due to licensing then the overall cost efficiency in the industry changes. Note that firm 1's marginal cost of production under export is higher than its marginal cost of production under FDI. So, if the firm 2's effective cost efficiency does not improve adequately due to licensing then this mode switch may create overall large cost inefficiency in the industry, which reduces domestic welfare. Thus, when the optimal licensing policy involves royalty rate  $r^* \geq \varepsilon$ , then the domestic welfare certainly goes down. Domestic welfare can improve after licensing only if the gain in effective cost efficiency by the domestic firm due to licensing is larger than the increase in inefficiency of firm 1's marginal cost due to the mode switch from FDI to exporting.

It is also clear from the proposition 5 that when the market size (captured by the demand intercept  $a$ ) in the host country is relatively large the domestic welfare goes down due to strategic use of licensing by the foreign firm. Hence, our results warn that developing countries with large domestic markets (such as China and India) need to be careful while encouraging all the modes of foreign operations as the foreign firm may recourse to strategic licensing prior to the choice of exporting or FDI.

In the light of the proposition 5 on welfare it is imperative to ask what would be the policy of the host government to avoid the welfare loss that occurs due to the strategic use of licensing by foreign firm. To this end this paper provides a new argument for an optimal tariff policy in the current era of globalization. Note that for large "technology gap" between the firm 1 and firm 2 i.e., if  $\varepsilon > \frac{(a-c)}{4}$  and small transportation cost  $t$ , there exists a tariff scheme say  $\tau^*$  such that  $t(\tau^*)$  belongs to the range where the post licensing consumers surplus improves and

also there would be additional revenue from tariff for the host government. This can be done by increasing  $t$  by  $\tau^*$  such that  $\frac{(a-c+\varepsilon)}{5} > t(\tau^*) \geq \frac{(a-c-\varepsilon)}{3}$  (see Proposition 5b(ii)).<sup>9</sup>

However, if there is a small technology gap between the firm 1 and firm 2 ( $\varepsilon \leq \frac{(a-c)}{4}$ ) then by imposing tariff to avoid welfare loss is not possible as any attempt to increase  $t(\tau^*)$  such that  $t(\tau^*) \geq \frac{(a-c+\varepsilon)}{5}$  would lead to  $t(\tau^*) > \varepsilon$  for small cost advantage. Thus, for small difference in technology efficiency there does not exist any positive tariff rate, which can improve the welfare of the domestic consumers post licensing. Thus, our model suggests that the licensing mode should be banned altogether for small difference in technology efficiency. Note that licensing always occurs in our model and the rationale for tariff in our model is to make the licensing contract more favourable to the consumers by improving the overall cost efficiency in the host country. However, as we have discussed earlier that in Kabiraj and Marjit (2003) tariff induces technology transfer which otherwise would not happen in equilibrium.

## 5. Conclusion

In this paper we have tried to analyse the interactions of different mode of operations for the foreign firm into a host country, which has received very little attention in the literature. We have shown that foreign firm would choose licensing its superior technology to a host firm strategically prior to its choice between FDI and exporting. This strategic licensing also affects the foreign firm's subsequent choice between FDI and exporting. Thus, we find that for some parameter ranges there is a switch of mode from FDI to exporting after licensing. The optimal licensing involves royalty licensing if the FDI is the equilibrium mode of operation. When exporting is the equilibrium mode choice then the foreign firm's optimal licensing policy can be fixed fee, royalty or a two part tariff. The welfare effect in the host country depends on the structure of license fee as well as the mode of operation of the foreign firm. When the foreign firm does not switch modes, then under either form of duopoly (exporting or FDI) the licensing of foreign technology either does not affect the host country welfare or it actually increases the welfare. However, the licensing would reduce welfare in

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<sup>9</sup> Note that we do not explicitly calculate the optimal tariff here. We simply suggest the existence of such a tariff policy which improves the host country welfare in the present setup.

the host country when the foreign firm switches mode of operation from FDI to exporting due to licensing and the overall cost structure in the industry becomes more inefficient. To this end this paper prescribes either an optimal tariff scheme for large difference in cost efficiency between foreign firm and the host firm or a complete ban on licensing for small difference in cost efficiency to maximize the host country welfare.

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