

# Technology transfer in a horizontally differentiated product-market

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**“Technology Transfer in a Horizontally Differentiated  
Product-Market**

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# Technology Transfer in a Horizontally Differentiated Product-market \*

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## Abstract

This paper considers technology transfer in a Cournot-duopoly market where the firms produce horizontally differentiated products. It turns out that without the threat of imitation from the licensee, the licensor always transfers its best technology. However, the patent licensing contract consists of up-front fixed fee and per unit output royalty for products of neither close substitutes nor isolated. In case the goods are close substitutes then only per unit output royalty is the optimal solution. However, whether the incentive for imitation increases with product differentiation is ambiguous. Hence, with the presence of credible imitation threat, the relation between the likelihood of best technology transfer and product differentiation is not clear always.

Key Words : horizontal product differentiation, imitation, technology transfer

JEL Classification : L13

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# 1 Introduction

Technology transfer is a topic of growing interest. Various aspects of technology transfer are by now well documented in the literature. In an oligopoly, where the transferer and the transferee compete in the same market, the basic issues related to the act of technology transfer reduces to the following. The transferer faces more aggressive behavior from the licensee after the technology is transferred. This compels the transferer, to repeat, in oligopoly, to design a licensing contract that can reduce competition from the transferee after the technology transfer. At the same time, the licensor can be concerned with the quality of the licensed technology. For the references relevant to the present work one may look at Rockett (1990) and Kabiraj and Marjit (1992, 1993). While Rockett (1990) is interested to examine the optimal patent licensing contract and the quality of the transferred technology in a duopoly when the licensee can imitate the licensed technology, Kabiraj and Marjit (1992, 1993) examine optimal quality of the licensed technology under the threat of entry from the licensee to the licensor's market.<sup>1</sup>

The present paper also considers a duopoly market where the licensor and the licensee compete in the same market. However, the present paper extends the literature on technology licensing by introducing horizontal product differentiation. By considering homogeneous goods, the previous works, we believe, have ignored an important factor of the practical life that may shape the patent licensing contract as well as the quality of the licensed technology. In the modern markets, different brand names of different firms producing same products may make their goods imperfect substitutes. In this work we argue that this structural factor (the degree of product differentiation) may have important role in designing patent licensing contract and also to decide the quality of the licensed technology.

We further examine the implications of the imitation threat from the licensee on the quality of the licensed technology. In otherwords, we examine whether relatively higher product differentiation will encourage relatively better technology to be transferred. In particular, we show that without the possibility of imitation threat, the licensor will always transfer its best technology and the patent licensing contract will consist of both the up-front fixed fee and a per unit output royalty provided the goods are not either isolated or close substitutes. For sufficiently close substitutes and for isolated goods, the optimal patent licensing contract consist of only per unit output royalty and only up-front fixed fee respectively. The existence of sufficiently higher product differentiation makes the competition less severe between the licensee and the licensor. Hence, it encourages the licensor to license its technology by a more non-distortionary

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<sup>1</sup>Also see Marjit (1990) for the profitability of licensing in a duopoly under fixed fee licensing contract. One can see Gallini and Wright (1990) and Singh (1992) for works on licensing when the licensor and licensee do not compete in the same market.

way. Therefore, as the goods are more imperfect substitutes, the licensor inclines to charge larger amount of up-front fixed fee and lesser per unit output royalty. But, if the goods are not very much imperfect substitutes, the possibility of severe competition from the licensee after the technology transfer induces the licensor to transfer its technology under a per unit output royalty only.

If the licensee, after getting the licensed technology, can imitate it, then it provides a constraint on the per unit output royalty. Now, for a positive cost of imitation, as the degree of product differentiation increases, on the one hand, it increases the incentive for imitation by making larger surplus from imitation for a given per unit output royalty; but, on the other hand, it encourages lower per unit output royalty in the patent licensing contract and hence makes imitation less attractive option. Thus, it turns out that for close substitutes the incentive for imitation increases as the products become more imperfectly substitutes. However, after certain degree of product differentiation, the incentive for imitation reduces as the products become more differentiated. Hence, we find that the threat of imitation shows a non-monotonic relation with respect to product differentiation. As a result, whether more product differentiation encourages relatively better technology with the presence of imitation threat is ambiguous. However, for products of sufficiently imperfect substitutes, the best technology transfer is a more likely outcome always.

The rest of the paper is organised on the following lines. In section 2 we describe the model and the results. Conclusions are provided in section 3.

## 2 Model and Results

Assume that there are two firms - 1 and 2 - competing in a market like Cournot duopolists with horizontally differentiated products. This product differentiation, as assumed in the paper, may be due to different brand names. Suppose firms 1 and 2 face demand functions<sup>2</sup> respectively

$$p_1 = a - Q_1 - \theta Q_2 \quad (1)$$

$$p_2 = a - Q_2 - \theta Q_1 \quad (2)$$

where,  $a > 0$  and  $0 \leq \theta \leq 1$ . The degree of horizontal product differentiation is measured by  $\theta$ . When  $\theta = 1$ , the goods are perfect substitutes and for  $\theta = 0$ , goods are unrelated. Let us assume that the (constant) marginal cost of production of firm 1,  $c_1 = 0$  (for simplicity), and of firm 2,  $c_2 \in (0, \frac{a}{2})$ .<sup>3</sup> Note, that the marginal cost of production reflects the technology of

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<sup>2</sup>This demand function is obtained from a consumer maximizing quadratic utility function.

<sup>3</sup>The upper bound on  $c_2$  ensures duopoly for all  $\theta$  under no-technology transfer. However, given  $\theta$ , duopoly structure under no-technology transfer will be sustained provided  $c_2 < \frac{a(2-\theta)}{2}$ . Therefore, for  $c_2 > \frac{a}{2}$ , under

a firm and has nothing to do with product differentiation. Further assume that there are no other costs of production.

First, let us consider the non-cooperative situation where the firms compete with their own technology. Here, firms 1 and 2 maximize respectively,

$$\max_{Q_1} \pi_1^o = \max_{Q_1} (a - Q_1 - \theta Q_2) Q_1 \quad (3)$$

and

$$\max_{Q_2} \pi_2^o = \max_{Q_2} (a - Q_2 - \theta Q_1 - c_2) Q_2. \quad (4)$$

The respective equilibrium output and profit of the firms 1 and 2 are given by

$$Q_1^o = \frac{a(2 - \theta) + \theta c_2}{(4 - \theta^2)}, \quad \pi_1^o = \frac{[a(2 - \theta) + \theta c_2]^2}{(4 - \theta^2)^2} \quad (5)$$

and

$$Q_2^o = \frac{a(2 - \theta) - 2c_2}{(4 - \theta^2)}, \quad \pi_2^o = \frac{[a(2 - \theta) - 2c_2]^2}{(4 - \theta^2)^2}. \quad (6)$$

Let us now consider the technology transfer situation. Under technology licensing firm 1 licenses its technology to firm 2. We assume that firm 1 can charge a fixed fee,  $F$  and a per unit output royalty,  $r$ , in a patent licensing contract. Initially, we do not restrict the value of  $F$  to be non-negative. However, in the due course, we do analyse the implications of the non-negativity constraint. The problem facing the licensor in case of technology transfer boils down to

$$\max_{F, r} F + rQ_2 + \pi_1^l(o, o + r) \quad (7)$$

$$s.t., F + rQ_2 + \pi_1^l(o, o + r) \geq \pi_1^o(o, c_2) \quad (8)$$

$$\pi_2^l(o, o + r) - F \geq \pi_2^o(o, c_2) \quad (9)$$

$$and \quad Q_i \geq 0, \quad i = 1, 2.$$

Constraints (8) and (9) are the respective participation constraints of firms 1 and 2. In this analysis, we assume that firm 1 behaves as a principal and makes a take-it-or-leave-it offer under patent licensing contract. Therefore, firm 1 considers constraint (9) with equality. Note, in this maximization problem we did not impose any non-negativity restriction for the choice variables. We solve this problem in the following manner.

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no-technology transfer, duopoly will be sustained provided  $\theta$  is less than a critical value and so in this situation one has to adjust the analysis accordingly.

First, let us solve the maximization problem considering (9) as an equality and ignoring the constraint (8). In this case, the maximization problem reduces to

$$\max_r rQ_2 + \pi_1^l(o, o+r) + \pi_2^l(o, o+r) - \pi_2^o. \quad (10)$$

This gives us the optimal value of royalty as

$$r^* = \frac{a\theta(2-\theta)^2}{(8-6\theta^2)} > 0, \text{ for } \theta > 0. \quad (11)$$

Second order condition for maximum is satisfied. Now (9) gives us the value of  $F$  such that constraint (9) is satisfied with equality. Therefore,

$$F^* = \frac{[a(2-\theta) - 2r^*]^2}{(4-\theta^2)^2} - \frac{[a(2-\theta) - 2c_2]^2}{(4-\theta^2)^2}. \quad (12)$$

From (12) it is clear that  $F^*$  varies negatively with  $r^*$  and for  $r^* > c_2$ ,  $F^* < 0$ . Therefore, to satisfy the condition that the fixed-fee must be non-negative,  $r^* \leq c_2$ . Further we have

$$\frac{\partial r^*}{\partial \theta} = \frac{(8-6\theta^2)[a(2-\theta)^2 - 2a\theta(2-\theta)] + 12a\theta^2(2-\theta)^2}{(8-6\theta^2)^2} > 0. \quad (13)$$

Therefore, optimal royalty rate varies inversely with the degree of product differentiation. Also note that at  $\theta = 1$ ,  $r^* = \frac{a}{2}$  and this in turn implies  $F^* < 0$ . But at  $\theta = 0$ ,  $r^* = 0$  and  $F^* > 0$ . From this it is clear that there exists  $\theta = \theta^*$  such that  $\forall \theta > \theta^*$ ,  $F^* < 0$  and  $\forall \theta \leq \theta^*$ ,  $F^* \geq 0$ , as  $r^*$  and  $F^*$  are continuous in  $\theta$ . It follows at once that if we introduce the non-negativity constraint on  $F$ , then  $\forall \theta > \theta^*$ ,  $r^*$  will not change and so  $r^* = c_2$  and  $F^* = 0$ .

So far we have not considered the participation constraint of firm 1. However, it can be easily verified that this constraint will be satisfied always. Here, we give the intuitive explanation avoiding the unnecessarily cumbersome algebra. Note, that firm 1 always has the option to chose  $r^* = c_2$  for any value of  $\theta$  and it will satisfy its participation constraint. But for  $\theta < \theta^*$ , it is optimal for firm 1 to set  $r^* < c_2$  and this will increase its profit. This implies that the optimal patent licensing contract derived as above satisfies firm 1's participation constraint.

The above analysis can be summarized in the following proposition.

**Proposition 2.1** (a) If  $1 \geq \theta \geq \theta^*$ , where at  $\theta^*$ ,  $r^* = \frac{a\theta^*(2-\theta^*)^2}{(8-6\theta^{*2})} = c_2$ , then  $r^* = c_2$  and  $F^* = 0$ .  
(b) If  $0 \leq \theta < \theta^*$ , then  $F^* > 0$  and  $r^* = \frac{a\theta(2-\theta)^2}{(8-6\theta^2)} < c_2$ .

Intuition of the above proposition is simple. If goods are sufficiently close substitutes, i.e.,  $\theta \geq \theta^*$ , then after technology transfer the licensor faces severe competition from the licensee. It induces the licensor to charge  $r^* \geq c_2$  and  $F^* \leq 0$ . But non-negativity constraint prevents firm 1 to charge a so high  $r^*$  since it will not satisfy the participation constraint of firm 2. Hence, the optimal patent

contract consists of  $r^* = c_2$  and  $F^* = 0$ . But when the goods are sufficiently differentiated, i.e.,  $\theta < \theta^*$ , technology transfer does not invite much competition from the licensee. This encourages firm 1 to charge a lower per unit output royalty reducing the output distortion resulting from per unit output royalty which in turn increases profit of firm 2. This extra profit is extracted by firm 1 with a non-distortionary up-front fixed fee. Also it is clear from Proposition 2.1(a) that  $\theta^*$  varies positively with  $c_2$ . Therefore, if the own technology of the licensee becomes more and more inefficient, the range of product differentiation over which the licensee charges only per unit output royalty increases. Hence, it highlights the importance of the licensee's own technology on the patent licensing contract.

In the above analysis we have assumed that firm 1 has only  $c_1$  technology rather than a range of technologies  $[0, c_2]$ . If firm 1 has all technologies lying between 0 to  $C_2$ , a natural question is the optimal choice of technology level that firm 1 will transfer. It can be seen easily that firm 1 will always transfer its best technology.

Suppose firm 1 transfers technology  $c \in [0, c_2]$ . Then profit of firm 1 is given by (firm 1's marginal cost of production is 0),

$$\frac{[a(2-\theta) + \theta(c+r)]^2}{(4-\theta^2)^2} + \frac{[a(2-\theta) - 2(c+r)]^2}{(4-\theta^2)^2} + \frac{r[a(2-\theta) - 2(c+r)]}{(4-\theta^2)} - \frac{[a(2-\theta) - 2c_2]^2}{(4-\theta^2)^2}. \quad (14)$$

To solve the optimal age of the licensed technology through backward induction first we have to choose optimum  $r$  given  $\theta$  and  $c$ , and then substituting optimal value of  $r$  in (14) we have to choose optimum  $c$ . The first order condition for maximization of (14) with respect to  $r$  is given by

$$\frac{2\theta[a(2-\theta) + \theta(c+r)]}{(4-\theta^2)^2} - \frac{4[a(2-\theta) - 2(c+r)]}{(4-\theta^2)^2} + \frac{[a(2-\theta) - 2(c+r)]}{(4-\theta^2)} - \frac{2r}{(4-\theta^2)} = 0 \quad (15)$$

$$\Rightarrow r^* = \frac{2\theta[a(2-\theta) + \theta c] - \theta^2[a(2-\theta) - 2c]}{(8-6\theta^2)}. \quad (16)$$

Second order condition is satisfied.

Now substituting this value of (16) in (14) and differentiating with respect to  $c$  we get after suitable substitutions the following:

$$-\frac{a(2-\theta) - 2(c+r^*(c))}{(4-\theta^2)} < 0. \quad (17)$$

This is due to the fact that the non-negativity constraint on fixed fee imposes a restriction  $c + r^*(c) \leq c_2$  on royalty payment. From (17) we can see that as  $c$  decreases, profit of firm 1 increases under technology transfer regime. From the foregoing analysis we can also see that best technology satisfies firm 1's participation constraint. This immediately gives us the following proposition.



**Proposition 2.2** *It is always optimal for firm 1 to sell its best technology.*

The reason for best technology transfer is easy to understand. Here without the possibility of imitation, the licensor has full flexibility to charge its patent licensing contract so that it can reduce the competition from the licensee after the technology transfer. Hence, it is always optimal to transfer its best technology since this will help the licensor to earn the maximum premium from technology transfer.

Therefore, without the credible threat of imitation, it is always optimal for the licensee to transfer its best technology. However, the introduction of horizontal product differentiation have important implications on the patent licensing contract. For  $\theta \in [0, \theta^*)$ , it is optimal for the licensor to make a combination of positive per unit output royalty (except for  $\theta = 0$ ) and positive up-front fixed fee in a patent licensing contract. Hence, this is in sharp contrast to the finding of previous work (see, e.g., Rockett, 1990). But for  $\theta \in [\theta^*, 1]$ , licensor sets only per unit output royalty in the licensing contract and charges no fixed fee. This restriction on fixed fee comes from the non-negativity constraint on fixed fee.

## 2.1 Implications of imitation

So far we have dealt with a situation where the licensor faces no threat of imitation. This may be due to the nature of technology or may be due to strong patent protection. Let us now relax this assumption and see the implications of the possibility of imitation<sup>4</sup>.

Suppose firm 1 has one technology  $c_1 = 0$  and assume that the licensee can imitate the licensed technology by incurring a cost  $I$ . For imitation to be a binding constraint we need  $I < \pi_2(0, 0; \theta) - \pi_2(0, r^*; \theta)$  ( $=k$ , say). This inequality shows that if imitation is a binding constraint then it imposes a constraint on the royalty payment and this in turn induces the licensor to charge lower per unit royalty and a higher fixed fee in such a way that  $I = k$  and (9) satisfies with equality.<sup>5</sup> Now, one has to look carefully at the participation constraint of the licensor. In this constrained situation technology may not be transferred at all as both the participation constraints cannot be satisfied simultaneously.<sup>6</sup>

Now, we look at the relationship between the threat of imitation and the degree of product differentiation. As  $\theta$  changes, two opposite forces are at work that change the value of  $k$ . For any given  $r$ , as  $\theta$  decreases (increases), the value of  $k$  increases (decreases) accordingly. But for

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<sup>4</sup>Here we assume that patent disclosure is not enough for imitation. To imitate the technology licensee needs technology.

<sup>5</sup>We assume that if the licensee is indifferent between imitation and no imitation then he will not imitate. Since in this constrained situation the adjustment of  $r$  and  $F$  is similar to that of Rockett(1990), we choose to omit the discussion in detail here.

<sup>6</sup>Mukherjee and Marjit (1997) shows this in a situation with costless imitation.

a lower (higher)  $\theta$ , optimal output royalty itself decreases (increases) which in turn decreases (increases)  $k$ . The net effect on  $k$  depends on the relative strength of these two forces. From our earlier analysis we see that  $\forall \theta \in [\theta^*, 1]$ ,  $r^* = c_2$ . If the variation in  $\theta$  falls in this range, then it will not change the optimal value of the per unit royalty payment,  $r^*$ . This in turn implies that for any change in  $\theta$ , the effect on  $k$  through a change in  $r^*$  is not in operation. Hence  $\forall \theta \in [\theta^*, 1]$ , we have  $\frac{\partial k}{\partial \theta} < 0$ . This means that in this range of  $\theta$ , as goods become less substitutable, threat of imitation increases. So  $\forall \theta \in [\theta^*, 1]$ , the amount of  $I$  which makes imitation as a binding constraint for  $\theta = 1$ , also makes this constraint binding  $\forall \theta \in [\theta^*, 1]$ .

For  $\theta < \theta^*$ , both forces are in operation and the effect on  $k$  for a change in  $\theta$  depends on the relative strength of these forces. Further we have  $k|_{\theta=\theta^*} > k|_{\theta=1} (> 0)$  since  $\frac{\partial k}{\partial \theta} < 0, \forall \theta \in [\theta^*, 1]$ . Also,  $k$  is continuous in  $\theta$  over the range  $[0, \theta^*]$  with  $k|_{\theta=0} = 0$  and  $\frac{\partial k}{\partial \theta}|_{\theta=0} > 0$ , and assuming monotonicity for  $\theta \in [0, \theta^*]$ , in this case, we can say that the threat of imitation falls as products are much differentiated. This is described in Figure 1. In this diagram  $k(\theta)$  shows the value of  $k$  when the licensor offers unconstrained (from imitation) patent licensing contract. Even when  $k$  is non-monotonic with respect to  $\theta$  over  $[0, \theta^*]$  we still get a value of  $\theta = \theta^0$  such that  $\forall \theta < \theta^0$ , this holds.

### Figure 1

From Figure 1 we see that if imitation cost is  $I_1$  then  $\forall \theta \in (\theta^c, 1)$ , imitation cost is binding and the licensor will charge less unit royalty and higher fixed fee than its unconstrained unit royalty. Therefore, this imitation cost gives further incentive for charging a fixed fee. However, this  $I_1$  is not binding constraint for  $\theta \leq \theta^c$  and  $\theta = 1$ . Similarly,  $I = I_2$  is a binding constraint for  $\theta \in (\theta_2, 1]$  but it is not binding for  $\theta \leq \theta_2$ .

Now we have the following proposition.

**Proposition 2.3** (a) For  $\theta \in [\theta^*, 1]$ , threat of imitation is positively related with the degree of product differentiation.

(b) There always exists a value of  $\theta = \theta^0$  such that  $\forall \theta < \theta^0$ , threat of imitation varies negatively with the degree of product differentiation<sup>7</sup>.

In the above analysis we have assumed that the licensor has only one technology,  $c_1$ . Now, let us consider the case where the licensor is endowed with a range of technology  $[0, c_2]$  instead of a unique technology  $c_1 = 0$ . In this case the optimal quality choice problem of the licensor when there is a threat of imitation can be discussed as below. We have seen from our earlier analysis that in case of non-binding imitation threat best technology will be transferred.

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<sup>7</sup>In Figure 1,  $\theta^0 = \theta^*$ .

Now, we consider another extreme situation where  $I = 0$ . In this case it is optimal for the licensor to charge zero royalty, i.e.,  $r^* = 0$ . Therefore, licensor will choose optimal  $c$  which maximizes the following expression:

$$\frac{[a(2-\theta) + \theta c]^2}{(4-\theta^2)^2} + \frac{[a(2-\theta) - 2c]}{(4-\theta^2)^2} - \frac{[a(2-\theta) - 2c_2]^2}{(4-\theta^2)^2}. \quad (18)$$

The expression (18) attains a minimum value at  $\hat{c} = \frac{a(2-\theta)^2}{(4+\theta^2)} > 0$ . Therefore, the licensor will either sell its best technology or no technology will be transferred. This in turn implies that in such a situation, the intermediate technologies effectively have no role to play and the condition for technology transfer is similar to the situation where licensor has only one superior technology rather than a continuum of technologies. Further we see that  $\hat{c} |_{\theta=0} = a$  and  $\hat{c} |_{\theta=1} = \frac{a}{5} < \frac{a}{2}$ . This implies that when  $\theta = 0$  the best technology will be transferred always. But at  $\theta = 1$ , there may be no technology transfer. Hence, for  $\theta = 1$  we have a finding akin to Marjit (1990). Further, it can be shown easily that there exists some degree of product differentiation such that the best technology will be transferred for all imitation costs.

Let us now consider a situation where products are differentiated to the extent where only very low imitation costs are binding. This imposes a constraint on the unit royalty too. Due to this very low imitation cost even an intermediate technology is not capable of generating a high royalty payment through a relatively (constrained) higher per unit royalty. But this will distort the output choice of the licensee. So, in such a situation best technology with relatively lower royalty and higher fixed fee generates more profit than an intermediate technology with higher royalty and lower fixed fee. One may get a similar argument in Rockett (1990) where lower imitation cost induces best technology transfer and, so, we are not going to the details of it. However, this high level of product differentiation makes relatively higher imitation cost as an incredible threat and this encourages best technology transfer. Thus, we see that while intermediate values of imitation cost can encourage intermediate technology transfer when the goods are homogeneous, as in Rockett (1990), sufficiently large product differentiation makes these imitation costs non-binding and best technology is transferred for all imitation costs.

However, product differentiation does not necessarily make best technology transfer more likely relative to the situation where the goods are homogeneous. Assume that  $I = I_1$  (see Figure 1) and  $\theta$  is close to  $\theta^*$ . With this  $I$ , best technology will be transferred for  $\theta = 1$ . But for  $\theta = \theta^*$ , this imitation cost may impose sufficient constraint which in turn may encourage the transfer of an intermediate technology with a relatively (constrained) higher royalty. Though this will reduce the amount of fixed fee due to higher effective cost of the licensee, it will eliminate sufficient competition faced by the licensor.<sup>8</sup>

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<sup>8</sup>Again this argument is similar to Rockett (1990) on the effect of intermediate imitation costs to the quality

The above analysis is summarized in the following proposition.

**Proposition 2.4** *Whether product differentiation, in the presence of imitation cost, will make best technology transfer more likely is ambiguous. However, if products are sufficiently differentiated (i.e.,  $\theta$  is very low) then best technology will be transferred for all imitation costs.*

### 3 Conclusion

In this paper we have taken a re-look at the question of technology transfer and the quality of the transferred technology when firms compete like Cournot duopolists in a market with *horizontally differentiated products*. As product differentiation *reduces* competitive rivalry between the licensor and the licensee, the licensor has an incentive to reduce output distortion of the licensee. This makes an optimal patent licensing contract consisting of *positive* up-front fixed fee and positive unit output royalty, when product differentiation is *sufficiently high*. At one extreme where goods are isolated ( $\theta = 0$ ), the licensor will charge only positive fixed fee with zero royalty per unit of output. But, the non-negativity constraint of fixed fee makes a constant unit output royalty for sufficiently low product differentiation (i.e, for  $\theta \in [\theta^*, 1]$ ) where up-front fixed fee is zero. In all these cases the licensor will sell its best technology when there is a choice with respect to the quality of the transferred technology.

Furthermore, we have shown that the threat of imitation is *reduced* as products are *sufficiently differentiated* but for products with *little differentiation* threat of imitation *increases*. Hence, the relationship between the quality of the licensed technology and degree of product differentiation under the credible threat of imitation is ambiguous. Thus, whether higher product differentiation will encourage better technology transfer with the presence of imitation threat is not certain always. However, we have shown that irrespective of imitation cost there exists some degree of product differentiation such that it is always optimal for the licensor to transfer its best technology.

In this analysis we have assumed that different brand names, packaging, etc., are responsible for the horizontal product differentiation. This product differentiation has nothing to do with the process technologies. The main purpose of this work is to examine the implications of horizontal product differentiation on the patent licensing contract, on the threat of imitation and on the technology choice. An extension of this work may be to endogenize the decision on product differentiation as well. Rather than brand names, packaging, etc., the R&D efforts of these firms can make these products imperfect substitutes. This issue and other related issues are in our future research agenda.

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of licensed technology.

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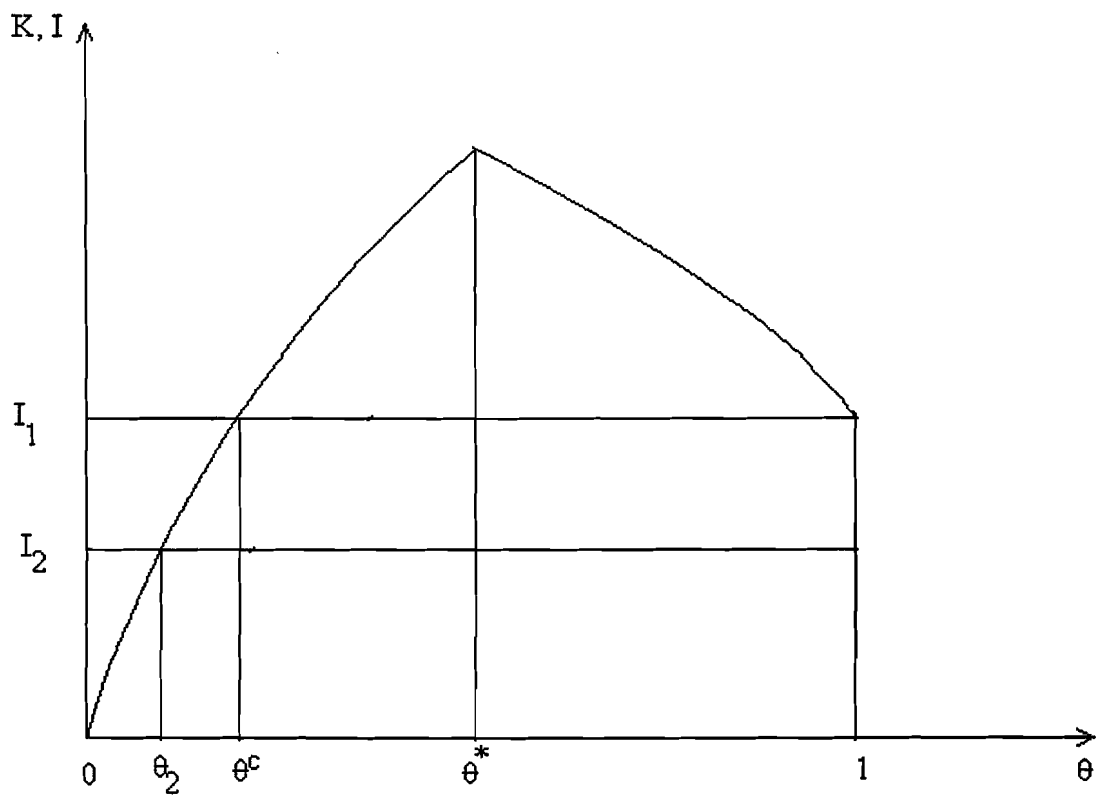


Figure 1