Licensing vs. Innovation Incentives under Uncertainties in Government Policies *

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Abstract

We discuss innovative incentives of a local firm when an advanced technology may be available through a foreign firm. The domestic government follows either protection or free trade policy, but there are uncertainties about the realization of a particular policy. We portray the situations in which licensing, either with or without innovation, occurs in equilibrium. We point out that without a binding contract equilibrium outcomes do not always maximize the aggregate industry profit. Also, negative license fee can occur in equilibrium. This analysis is then applied to the controversial question of whether the liberalization policy generates sufficient incentives for domestic innovation. In particular we show that, under the same parametric situation, an innovation decision can be optimal if a protective policy prevails with certainty, while licensing occurs if free trade prevails for sure. The paper also shows that innovation incentives can be strictly lower where the government cannot commit to its liberalization policy so as not to intervene in case of failure.

Key words: liberalization; protection; licensing; innovation; bargaining.

JEL classification numbers: F13, O33.

1 Introduction

Long term economic performance of a country depends, to a crucial extent, on the endogenous technological advances. Technological backwardness is identified as the singlemost important cause of economic backwardness and underdevelopment of the developing nations[1]. Most of the LDCs have, however, failed to motivate their firms to invest sufficiently in research and development (R&D). And so far, they have performed very poorly in respect of technology generation. These countries have mostly relied on technology imports through licensing collaborations with the advanced foreign firms.

We also observe that these countries followed a protectionist policy for a long time. Possibly they were of the view that protected monopolies would give the local firms sufficient incentives to undertake R&D activities. But as it is evident from the experience of many developing countries during the last fourty years or so, protectionist policies did not create much incentives for the domestic firms to develop indigenous technological advances to any meaningful extent. As a result, protectionist policies has come under serious criticism since the 80s, and there had been an all round propaganda to liberalize the economy with a view to create a competitive environment, and it was believed that this new environment would provide necessary

[1]Stewart (1981) discusses why the developing countries should try to develop their own technological capability. The importance of technological advances in growth and economic development is quite obvious from the works of Solow (1957), Denison (1962) and Romer (1990), only to mention a few.

incentives for endogenous technological progress[2]. Thereafter many developing countries have switched over from a period of protection to gradual liberalization and opening up, with China and India, the two basins of protectionism, being no exception. The World Bank, the IMF and, in particular, the industrially advanced nations have always insisted on this change.

One might have reasons to argue that in a closed economic framework there are a lot of incentives deterring independent research activities[3], but one should not be over-optimist about the liberalization policy. One should also keep in mind that most of the LDCs have accepted the liberalization policy under macro-economic adjustment pressure of the World Bank and IMF. Will a liberalization policy generate sufficient incentives for R&D? This remains a moot question. In our paper we show in terms of a simple model that for some parameter constellations, the LDC firms might prefer risky innovation if protection is guaranteed while licensing will take place if free trade occurs with certainty. The higher the success rate of innovation to catch up the foreign technology level, the more likely does this case occur.

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[2]See Dornbusch (1992) for other arguments in favour of a liberalization policy. Mookherjee and Ray (1991) have reconciled the ideas of Schumpeterian protection and Leibensteinian competition in the context of sequencial innovations.

[3]See Kabiraj (1993). In particular, Kabiraj has shown that, given the technology licensing available, if the LDC firms do not find high probabilities of large innovations from their research efforts, they do avoid such risky ventures and instead prefer licensing as a better alternative. For the relation between an appropriate market structure and innovation incentives see Kamien and Schwartz (1982).

Since LDCs often have to implement a liberalization policy in a situation of economic disorder and political instability, there is an inherent element of uncertainty in the continuation of the same policy for a long time. Changes in the economic and political environment often result in a change of the policy pursued at the present. Since investment and R&D decisions are taken on long term considerations, the present switch to a liberalization policy may not create that competitive pressure in the minds of the potential innovators. This type of uncertainty in the government trade policy has been modeled in the present paper by introducing randomness in the realization of the future government policy.

In the literature of technology licensing the technology supplier often seem as so powerful that they can dictate the terms and conditions of the licensing agreement. There are, in fact, evidences to show that the technology licensors sometimes impose terms that retard local R&D.[4] However, since licensing terms prohibiting the licensees' independent R&D activities are generally not enforcible, we assumethat a local firm can always continue its innovative research, if it so desires[5]. In our analysis with a positive chance of surpassing the licensed technology through own R&D, the licensing agreement can act as a partial insurance to the licensee. Hence, in our paper, any of the cases of licensing with innovation, licensing without innovation, or innovation without any licensing agreement can occur

[4]See the RBI Survey 1968-85, and Swaminathan (1988)

[5]In Gallini (1984) licensing has been used as an alternative strategy to deter R&D of the rival.

in equilibrium. Given these possibilities, there can be conflicts of interests between individual firms and the industry as a whole. In particular we have situations where licensing is profitable for the industry as a whole but the firms cannot write a binding contract to achieve it.

In the licensing literature, LDC firms are generally portrayed as of less bargaining power. The technology suppliers are given enough control instruments by which they can extract all surplus from the use of the licensed technology. But it should be mentioned that during the past years the LDC firms, while dealing with the multinationals, have gathered experience and knowledge and can potentially compete with the technology suppliers. This has strengthened the former's bargaining power, and the technology buyers are now equally capable of dictating the licensing term. In such a situation license fee should be determined in a bargaining game. In our paper we apply Nash Bargaining Solution to determine the license fee, which divides the bargaining booty equally. If we define the license fee as the (net) transfer from the licensee to the licensor, then our paper has included an interesting possibility of negative transfer. With uncertainties in the future trade policy, we can have this case if the domestic firm finds reasonably high probability to catch up with the foreign firm through its local R&D efforts. A negative license fee under licensing agreement can occur as a deterrence to domestic R&D.

We have already referred one form of uncertainties in government policies. Uncertainties can also arise because of the failure of the government to credibly commit its trade liberalization policy to the private investors and firms, both domestic and foreign. This means that the public is not sure whether the government currently in power pursues a lasting reform or just a temporary one and will return to protection at some future date. Rodrik (1989), Aizenman (1992) and Buffie (1995), to mention a few, have discussed this issue[6]. In our paper we refer to the case when it is apprehended that an optimal ex post strategy of the government may differ from its optimal ex ante strategy. Since decisions on licensing and innovations are taken ex ante much before the realization of the government policy, this uncertainty is a common problem. Suppose for some parametric configuration an innovation decision is optimal if the free trade policy could be fully committed to. Now if firms apprehend that for some reasons the government may not be able to keep its commitment fulfilled, and there is a positive chance of government intervention that reduces industry profits, in our paper incentives to innovation strictly get reduced, and licensing instead of innovation are more likely to occur.

The paper is organized into three sections. The second section presents the model and results, and the third section provides a summary of the results.

[6]Rodrik (1989) notes that one source of credibility problems is incomplete or asymmetric information. Private investors may be in the dark about the true objective of the government in power, or may confuse it with an alternative government whose objectives differ. Imperfect information is particularly likely to be prevalent in countries where governments (and finance ministers) rotate frequently, as in many developing countries.

2 Model

We consider a situation in which one domestic firm (called firm 1) and one foreign firm (called firm 2) are capable of supplying a homogeneous good in the domestic market. Dependent on which political party wins the coming election, either protection or free trade may turn out to be the prevalent economic policy. Naturally, there is uncertainty for the firms about the realization of a particular policy. If the relevant policy is protection, then firm 1 operates in the home market realizing a monopoly profit with the technology available to him. If the policy of free trade or market prevails, we have a duopoly situation, with possibly asymmetric technologies. Let $\theta \in [0, 1]$ denote the probability of protection. Then $(1-\theta)$ is the probability of free trade. We assume that θ is common knowledge.

It is a two period model. At time $t = 0$ firms make their decisions about innovation, licensing, etc. Initially, there is a gap between firm 2's advanced technology, c_1, and firm 1's less advanced one, c_0. We interpret these technologies as constant marginal costs of production (so that $0 < c_1 < c_0$), although this is not necessary. Regarding technology, we assume that the foreign firm follows an exogenous path of innovation and, therefore, will improve her technology from c_1 to c_2 at $t = 1$, independent of any other issues relevant to our analysis. However, the domestic firm either can improve its technology to c_1 with certainty, if a licensing agreement (L) is settled at $t = 0$ and the domestic firm adopts the licensed technology before $t = 1$, or to c_2, if the firm be successful with its independent innovative efforts (I). We assume that to adopt the licensed technology the licensee will have to spend a fixed sum of money at the beginning of $t = 0$, whose value evaluated at $t = 1$ is K. Let p_0 be the probability of achieving c_2 technology at $t = 1$. For simplicity there is a zero probability for c_1 technology. Then $(1 - p_0)$ is the probability of not at all improving the technology through the innovative efforts. Hence, the future possible state of technologies can be either (c_0, c_2), or (c_1, c_2), or (c_2, c_2) with $c_0 > c_1 > c_2$. These states of technologies will be denoted by s_{-2}, s_{-1} and s_0 respectively, where the subindices reflect the technological gap between the two firms.

Innovative research is not only risky but also costly. If the domestic firm decides to undertake its own R& D effort, we assume that it will have to invest a fixed sum of money at $t = 0$ as sunk costs. Its value evaluated at $t = 1$ is R', $R' > K$. For algebraic convenience let us define $R = R' - K$, $R > 0$. Theoretically, in the no-licensing situation, no-action (N) at all is also possible. As we are interested in the cases when licensing interferes with incentives to innovation, we assume that firm 1 always prefers innovation to doing nothing, given (p_0, R, K).

A licensing agreement between the firms states that, at $t = 0$, the foreign firm is to transfer her current technology c_1 to the domestic firm and charges a net license fee l for the licensed technology. Note that firms cannot make a contract on c_2 technology which is not yet available. In our case $l = (f - n)$, where f is the money transferred directly from the domestic to the foreign firm but the foreign firm is to transfer n to the domestic firm as services or inputs needed to adopt the technology for commercial production by the domestic firm. This refers to the technology transfer cost incurred by the transferor (see Teece (1977) in particular). We have already pointed out that the domestic firm will have to spend K if its decision is to adopt the licensed technology. It will be clear very soon to the reader why we have defined l in that way. Our analysis includes the possibility that in the licensing equilibrium net license fee (i.e., l) can be negative, although the money transferred directly from the licensee to the licensor is always to be positive.[7]

Now, given the licensing agreement, it does not, however, preclude the domestic firm to invest in research and development. In fact, there can be incentives for doing innovative research even when the firm has already accepted the licensing contract. The reason is that through licensing the domestic firm can have at most the c_1 technology, whereas through innovative efforts it can achieve the c_2 technology with positive probability. Since in case of failure, the domestic firm can at least get c_1 technology for sure, the licensing agreement may be accepted as insurance in the situation of risky innovation.

So, under the licensing agreement we have three possible actions by the domestic firm, viz., licensing with no innovation ($L\backslash I$), licensing along with innovation ($L\&I$), and innovation without adoption of the licensed technology ($I\backslash L$). $I\backslash L$ is basically the decision of innovation abondoning licensing, by not incurring the cost K to adopt the licensed technology.

[7]Even if the foreign firm wishes to discourage the domestic firm from innovations, which can happen as we will see, it shall not look like a bribery.

Yet, as the licensing contract is already signed, the domestic firm still has to pay f while the complementary services n provided by the foreign firm will remain idle.

To formalize the game we suppose that an (fictive) arbitrator proposes a licensing contract with the net license fee l, and the firms are to decide whether they accept or reject the contract. If rejected, the domestic firm has two actions, I and N. If accepted, the domestic firm will follow either $L\backslash I$, $L\&I$ or $I\backslash L$. This is portrayed in the Game Tree below.

[FIGURE 1]

Let $S = \{s_{-2}, s_{-1}, s_0\}$ denote the space of possible technology states and $A = \{I, N, L\backslash I, L\&I, I\backslash L\}$ denote the action space for the domestic firm. For any $a \in A$, we can define the cost/transfer functions as follows :

$$k_1(a) = \begin{cases} 0 & \text{if } a = N \\ -(R+K) & \text{if } a = I \\ -(l+K) & \text{if } a = L\backslash I \\ -(R+K+f) & \text{if } a = I\backslash L \\ -(R+K+l+K) & \text{if } a = L\&I \end{cases} \tag{1}$$

for the domestic firm and

$$k_2(a) = \begin{cases} 0 & \text{if } a = N, I \\ l & \text{otherwise} \end{cases} \tag{2}$$

for firm 2. We have already assumed that I dominates N. Also, by construction, action $I\backslash L$ is always dominated by I because of $f > 0$ to be paid. Hence under licensing agreement we are left with only two actions for the domestic firm, $L\backslash I$ and $L\&I$, while under no-licensing only action I remains. For these remaining relevant strategies the probabilities of achieving a particular state of technology are defined as below.

$$\begin{array}{c|ccc} & s_{-2} & s_{-1} & s_0 \\ \hline I & 1-p_0 & 0 & p_0 \\ L\backslash I & 0 & 1 & 0 \\ L\&I & 0 & 1-p_0 & p_0 \end{array} \tag{3}$$

Let $v_i(a,\theta)$ denote the net payoff of firm i when action a is chosen and the corresponding action-dependent probability in state s is $p_s(a)$. Then

$$v_i(a,\theta) = \theta \sum_{s\in S} p_s(a)\pi_i^m(s) + (1-\theta)\sum_{s\in S} p_s(a)\pi_i^d(s) + k_i(a) \tag{4}$$

where $\pi_i^m(s)$ is the gross profit of firm i when the market structure is monopoly of the domestic firm (because of protection) while it is $\pi_i^d(s)$ when duopoly of both firms, because of free trade, prevails.

Obviously, $\pi_2^m(s) = 0$. Also $\pi_1^d(s_{-2}) = 0$ is possible if the gap in production technologies in state s_{-2} is too big.

It should be noted that under a licensing agreement v_i depends on l, but the industry profit $v(a,\theta) = v_1(a,\theta) + v_2(a,\theta),\ a \in A$, is independent of l.

For a more precise notation, let us denote $\pi^\theta(s)$ as the θ-weighted average of industry profits under monopoly and duopoly market structure, given the state of technology s, i.e.,

$$\pi^\theta(s) = \theta\pi_1^m(s) + (1-\theta)(\pi_1^d(s) + \pi_2^d(s))$$

Hence, the industry profit has the form

$$v(a,\theta) = \sum_s p_s(a)\pi^\theta(s) + k_1(a) + k_2(a) \tag{5}$$

Similarly, we can rewrite the expression of $v_i(a,\theta)$ as

$$v_i(a,\theta) = \sum_{s\in S} p_s(a)\pi_i^\theta(s) + k_i(a) \tag{6}$$

where

$$\pi_i^\theta(s) = \theta\pi_i^m(s) + (1-\theta)\pi_i^d(s).$$

From the expression of $v_i(a,\theta)$ it can easily be observed that $v_1(L\backslash I,\theta)$ can be less or greater than $v_1(L\&I,\theta)$. For convenience we ignore the possibility of equality throughout our analysis. The direction of the inequality determines the solution of the subgame starting after "Accept" where both agree on the proposed contract. Hence $L\backslash I$ will be the perfect equilibrium outcome if and only if

$$\begin{cases} v_1(L\backslash I,\theta) & > & v_1(L\&I,\theta) \\ v(L\backslash I,\theta) & > & v(I,\theta) \end{cases} \tag{7}$$

Similarly, $L\&I$ will be the perfect equlibrium if and only if

$$\begin{cases} v_1(L\&I,\theta) & > & v_1(L\backslash I,\theta) \\ v(L\&I,\theta) & > & v(I,\theta) \end{cases} \tag{8}$$

Otherwise, I is the equilibrium decision. More precisely, if (7) or (8) holds, there is always some l such that both firms prefer licensing to no-licensing. This is crucial since two parties are needed for an agreement.[8]

[8] In fact, if $\max\{v(L\backslash I), v(L\&I)\} > v(I)$, then there is always a licensing agreement that gives both more than in I. Yet, this agreement may not be in equilibrium as firm 1 may have incentive to deviate.

Given (7) and (8), to further characterize the equilibria some additional assumptions are needed.

$$\text{(A1)} \qquad \pi^\theta(s_0) > \pi^\theta(s_{-1}) > \pi^\theta(s_{-2})$$

This states that the industry profit increases with diminishing technology gap. This order of inequality necessarily holds for $\theta = 1$. For $\theta = 0$, the duopoly case, the relations are in general ambiguous. Under Cournot duopoly with the demand function $P = a - Q$, the industry profit is

$$\pi^d(c', c'') = \frac{1}{9}[(a - c')^2 + (a - c'')^2 + 4(c' - c'')^2] \tag{9}$$

if c', c'' be the marginal costs of two firms. Suppose the relevant parameters in our analysis have the values

$$a = 20, \ c_0 = 16, \ c_1 = 12, \ c_2 = 10 \tag{10}$$

then it is obvious that (A1) holds for $\theta = 0$. Since π^θ is a convex combination of π^m and π^d, (A1) holds for all $\theta \in (0, 1)$ in this case.

We also assume

$$\text{(A2)} \qquad D \equiv \pi^\theta(s_{-1}) - \pi^\theta(s_{-2}) > K$$

and

$$\text{(A3)} \qquad Z \equiv \pi_1^\theta(s_0) - \pi_1^\theta(s_{-1}) > R + K.$$

The first inequality states that adoption of c_1 technology by firm 1 is feasible from the viewpoint of the industry. The second inequality states that even when c_1 technology is available to the domestic firm, the innovation decision (of c_2) is worth-taking whenever innovation is certain. The following statements are to be noted for the subsequent analysis.

$$v_1(L\backslash I,\theta) \gtrless v_1(L\&I,\theta) \Longleftrightarrow p_0 \lessgtr \sigma^\theta \equiv \frac{R+K}{\pi_1^\theta(s_0)-\pi_1^\theta(s_{-1})} \tag{11}$$

$$v(L\backslash I,\theta) \gtrless v(I,\theta) \Longleftrightarrow p_0 \lessgtr \alpha^\theta \equiv \frac{\pi^\theta(s_{-1})-\pi^\theta(s_{-2})+R}{\pi^\theta(s_0)-\pi^\theta(s_{-2})} \tag{12}$$

$$v(L\&I,\theta) \gtrless v(I,\theta) \Longleftrightarrow p_0 \lessgtr \beta^\theta \equiv 1-\frac{K}{\pi^\theta(s_{-1})-\pi^\theta(s_{-2})} \tag{13}$$

With these the equilibrium outcomes can be characterized from (7) and (8) as follows.

$$\text{The equilibrium is } \begin{cases} L\backslash I & \text{if } \ p_0 < \min\{\sigma^\theta,\alpha^\theta\} \\ L\&I & \text{if } \ p_0 \in (\sigma^\theta,\beta^\theta) \\ I & \text{otherwise} \end{cases} \tag{14}$$

The following proposition is then straightforward.

Proposition 1 *Assume (A1)-(A3). Let a_1, a_2 be an arbitrary pair of the parameters σ^θ, α^θ and β^θ. Then, for every parameter configuration $(\sigma^\theta,\alpha^\theta,\beta^\theta)$ we can find a_1, a_2 such that $L\backslash I$ is the equilibrium outcome forall $p_0 \in (0,a_1)$, while I is the outcome for all $p_0 \in (a_2,1)$. Moreover,*
(i) if $\beta^\theta < \min\{\sigma^\theta,\alpha^\theta\}$ or $\alpha^\theta > \beta^\theta > \sigma^\theta$, then $a_1 = a_2$, i.e. no other equilibrium outcome is possible;
(ii) if $\sigma^\theta < \min\{\alpha^\theta,\beta^\theta\}$, then $a_1 \neq a_2$ and L&I is the equilibrium outcome for $p_0 \in (a_1,a_2)$;

(iii) for the remaining configuration of $\alpha^\theta < \sigma^\theta < \beta^\theta$, $\alpha^\theta = a_1 \neq a_2 = \beta^\theta$ *and the outcome is* I *in the interval* $(\alpha^\theta, \sigma^\theta)$ *but* $L\&I$ *in* $(\sigma^\theta, \beta^\theta)$.

[FIGURE 2]

Figure 2 is an illustration.[9] Up to (iii), the results are quite intuitive. If the success rate p_0 is very high, firm 1 will always want to do I. If it is very low, licensing is the best while additional R&D efforts do not pay. For the medium values of success rate, licensing as an additonal insurance for own R&D effort might be feasible as in case (ii). In case (iii), for $p_0 \in (\alpha^\theta, \sigma^\theta)$ the industry profit is not high enough to sustain an $L\backslash I$ equilibrium which is also the preferred action by firm 1. Thus, though $L\&I$ yields higher industry profit, it can not prevail in equilibrium. Only when the success rate is high enough as for $p_0 \in (\sigma^\theta, \beta^\theta)$ can a licensing contract be agreed upon which serves as an insurance to firm 1's own R&D efforts.

Corollary 1 *There are situations where licensing is profitable to the industry as a whole but no licensing turns out in equilibrium.*

Furthermore, notice that because of

$$\pi_1^\theta(s_0) - \pi_1^\theta(s_{-1}) > \pi^\theta(s_0) - \pi^\theta(s_{-1})$$

[9]If assumption (A1) is for instance replaced by $\pi^\theta(s_{-2}) > \pi^\theta(s_0) > \pi^\theta(s_{-1})$, similar results can be derived analogously. With this assumption we can immediately see that $L\&I$ is never feasible (i.e., $v(L\&I) < v(I)$ for any p_0). Now if $R > \pi^\theta(s_{-2}) - \pi^\theta(s_{-1})$, then for all $p_0 \in [0, \sigma^\theta]$, $L\backslash I$ is equilibrium and for $p_0 > \sigma^\theta$, I is an equilibrium decision. However, if $R < \pi^\theta(s_{-2}) - \pi^\theta(s_{-1})$, suppose $v(L\backslash I) - v(I)$ intersects the horizontal axis at $\gamma < \sigma^\theta$. Then for $p_0 \in [\gamma, \sigma^\theta]$ equilibrium is $L\backslash I$; otherwise, I is equilibrium. One can similarly develop analysis for other possible assumptions.

there always exists some $p^* > \sigma^\theta$ such that

$$v(L\backslash I) \gtrless v(L\&I) \iff p_0 \lesseqgtr p^*.$$

Hence, for $p_0 \in (\sigma^\theta, \min\{p^*, 1\})$, the industry as a whole prefers $L\backslash I$ while firm 1 prefers $L\&I$ which comes out in equilibrium if $\sigma^\theta < \alpha^\theta < \beta^\theta$. Thus, we have

Corollary 2 *There are situations where indusrty as a whole has higher incentives for $L\backslash I$ but the perfect equilibrium is $L\&I$.*

One question that often comes across in the analysis is: Which market structure is favourable for innovation? In our case, which trade policy will provide more incentive for innovation? Recently, propaganda in favour of trade liberalization has been found everywhere. It is argued that, given that technology licensing is allowed, a closed economic framework may not generate sufficient incentives for doing research and innovative activities (Kabiraj (1993)). Competitive pressure under the liberalized environment should lead to more R&D investment and hence more growth. Thus, conventional wisdom suggests that LDC firms' incentives for innovation under free market are in general higher than under protection.

However, given the licensing opportunity modeled here, this intuition does not necessarily apply. The reason is that an individual duopoly firm's expected profit under innovation might be higher than doing nothing, but the industry as a whole can have incentives for licensing. We can show that if protection is expected instead, there may not exist any room for licensing agreement to take place in those situations.

Proposition 2 *There are ranges of parameters for which there will be innovation in equilibrium if a protection policy prevails for sure while licensing (without innovation) will be the equilibrium decision if market is for sure.*

Proof : We have to prove that there exists non-empty set of p_0 such that if $\theta = 0$, licensing without innovation comes up as an equilibrium decision, but if $\theta = 1$, innovation (with or without licensing) will occur in equilibrium.

From Prop. 1 we know that there always exists some $a_1^\theta \in \{\sigma^\theta, \beta^\theta, \alpha^\theta\}$ such that $L\backslash I$ is the equilibrium for $p_0 < a_1^\theta$ while innovation is in equilibrium if $p_0 > a_1^\theta$. If the parameters are such that $a_1^1 < a_1^0$, then $L\backslash I$ is the equilibrium for all $p_0 \in (a_1^1, a_1^0)$ if free market is sure while either I or $L\&I$ is the equilibrium if protection is expected with certainty. Now consider a situation with the parameters given in (10). Assume $R = 3$ and $K = 0$ in addition, we have $a_1^\theta = \sigma^\theta$ while $\sigma^1 < \sigma^0$. [QED]

Our result shows that a priori we cannot say which market structure (trade poliocy) provides more incentives for innovation, because the decision on innovation or licensing also depends on some other considerations outside the trade policy parameters. So abandoning protection does not necessarily mean higher incentives to innovation, as believed by common wisdom.[10]

[10]Had there been any possibility of invading foreign markets with goods by the domestic firm after the innovation occured, incentives for indigenous innovations could be larger. However, in our model there is no such possibility as there is no foreign market modeled.

For the latter part of the analysis we consider licensing and innovation without distinguishing between licensing with innovation and licensing without innovation, and follow the notation L for licensing.

Next question that we discuss is how the licensing fee (l) is determined in a licensing agreement. Let us suppose that l is the outcome of the Nash Bargaining Solution (NBS). The threat point for licensing agreement is then $(v_1(I,\theta), v_2(I,\theta))$ as firm 1 always has incentives to innovate in case of no licensing. Let $\tilde{v}_i(L,\theta)$ be the payoff of firm i under licensing but before thelicense fee is transferred. Then under NBS total surplus is shared equally, that is,

$$v_1(L,\theta) = v_1(I,\theta) + \frac{1}{2}(v(L,\theta) - v(I,\theta)). \tag{15}$$

The license fee is then determined from the following relation,

$$v_1(L,\theta) = \tilde{v}_1(L,\theta) - l$$

Hence, noticing that $\sum_1^2 \tilde{v}_i(L,\theta) = v(L,\theta)$, we have

$$l = \frac{1}{2}[(\tilde{v}_1(L,\theta) - v_1(I,\theta)) - (\tilde{v}_2(L,\theta) - v_2(I,\theta))]. \tag{16}$$

This expression shows that licensing fee might be negative, meaning that firm 2 has to pay firm 1 for not investing in research. If $\theta = 1$, i.e., protection is for sure, then $\tilde{v}_2(L) - v_2(I) = 0$. Thus license fee is always positive in this case. If $\theta = 0$, however, the license fee could be negative. From (16) this happens if firm 2 gains more from the licensing agreement. Suppose $R = 0$ while $K > 0$ is such that

$$p_0(\pi_1^d(s_0) - \pi_1^d(s_{-1})) < K < p_0(\pi_1^d(s_0) - \pi_1^d(s_{-2})). \tag{17}$$

This implies that firm 1 has sufficient incentive for innovation if its default MC is c_0, but not so if it is c_1. In particular, this means that firm 1 will not invest into further R&D under a licensing agreement. Now, as

$$\tilde{v}_1(L,0) - v(I,0) = R + \pi_1^d(s_{-1}) - (\pi_1^d(s_0)p_0 + \pi_1^d(s_{-2})(1-p_0)), \qquad (18)$$

it is negative for sufficiently large $p_0 \in [0,1]$. Suppose $\pi^d(s_{-1}) > \pi^d(s_0)$, which is the case for instance if $a = 10$, $c_0 = 9$, $c_1 = 8$, $c_2 = 5$[11], licensing with no innovation is then the equilibrium outcome with $l < 0$.[12] With this the following statement holds.

Proposition 3 *In our model, license fee can be negative.*

In Proposition 2 we have noted that abandoning protection does not necessarily mean higher incentives for innovation. Then there is often the concern that under the pressure of competition domestic firms may be unable to keep operation. This may cause widespread unemployment and possibly social unrest, among other issues. In our model, this may happen if the local firm ex ante decided to take the risk to innovate but failed, widening the technology gap. To avoid the undesirable effects, the government may feel obliged to intervene even if free trade had been promised, to soften the consequences of competitive pressure for the local firms. Suppose that under such circumstances the firms apprehend that the government will

[11] In fact, we have $\pi^d(s_{-2}) > \pi^d(s_{-1}) > \pi^d(s_0)$ for these parameters. Yet, firms cannot write binding contracts that prevent firm 1 from doing its own R&D. So, the highest industry profit cannot be realized in equilibrium.

[12] Note also that in this example the license fee is even negative if the licensor is given the full bargaining power.

impose a mild tariff on foreign products, say τ per unit, so that the local firm can survive, if it fails to innovate. Then the industry profit $v(I, \theta; \tau)$ shrinks with increasing τ, at least for small τ.[13] In particular, we consider those situations for which

$$v(I, \theta; \tau = 0) > v(I, \theta; \tau > 0).$$

In our model incentives to licensing is described by the difference $v(L, \theta) - v(I, \theta)$. Thus an apprehension of a positive τ increases incentives for licensing. Then it is trivial to show that there are cases where $v(I, \theta; \tau = 0) > v(L, \theta)$, while $v(I, \theta; \tau > 0) < v(L, \theta)$. Put differently, an apprehension of the conditional government intervention can strictly alter the outcome from innovation to licensing. So we can write the following proposition.

Proposition 4 *If there is a positive probability of market intervention whenever the local firm fails to innovate, then compared to the unrestricted free trade the incentive to innovate in case of market intervention is strictly lower. Moreover, there are situations where licensing occurs under $\tau > 0$ while innovation takes place under $\tau = 0$.*

This means that as to encouraging innovation a compromised free trade policy is dominated by an uncompromised one. Since the innovation/licensing decision is taken ex ante, before any realization of government policy in the future, policy makers face a serious commitment problem indeed when promising free market.

[13] We tacitly assume that the government is not allowed to confiscate a sum of firm 2's profit and give to the domestic firm, in which case there would be no difference in industry profits.

3 Conclusion

In this paper we provide a review of licensing contracts vis-a-vis innovation incentives of a domestic firm. In particular, we review some commonly held beliefs in the context of innovation and licensing game between a local firm and a foreign firm, and we provide some contrary results. We have assumed that the local government can follow either a free trade or a protection policy, but there is uncertainty in the realization of a particular policy. When a local firm signs a licensing contract with a foreign firm, the local firm may continue its innovative research and can reach the foreign technology level with positive probability. Then in equilibrium we have any of licensing with innovation, licensing without innovation and innovation without any licensing contract. Obviously, licensing with innovation cannot occur if the probability of success in innovation is very small. There are situations where industry as a whole has larger incentives for licensing without innovation but the perfect equilibrium can be licensing with innovation. Also there are situations when licensing is feasible for the industry as a whole, but the firms cannot write a binding contract on licensing.

The advocates of the trade liberalization policy generally press the LDCs to open up their economies and to follow a free trade policy. They argue that under the liberalization environment competitive forces will generate sufficient incentives for the LDC firms to do research and innovative activities. But as we have shown, there are situations where under protectionism innovative incentives are higher, while under free trade licensing is preferred. We have also shown the possibility that in a licensing contract net license fee can be negative. In fact when a technology is transferred, the technology supplier has to incur a cost in the stage of adoption by the transferee[14] and in our paper this cost may be larger than the direct money transfer from the technology buyer to the technology seller. Thus charging a (net) negative license fee can be a strategy of the multinational firm to deter local R&D.

In a democratic country where a government comes to power through an election process, there are various pressure groups which can influence the voters and public policies to be implemented[15]. Hence there are uncertainties in government policies. But the decisions of licensing or innovations are made ex ante much before the realization of a particular government policy. Given these uncertainties, decisions regarding innovation and licensing depend, among other things, on the present and future technology levels of both the domestic and foreign firms, along with the success probabilities. Other types of uncertainty might arise due to the failure of the government to credibly commit to its liberalization policy.[16] In particular, the firms might perceive a positive chance that the government may fail to keep its present commitment in the future and intervene by (say) a tariff. These

[14]See Teece (1977) for this type of costs involved in a technology transfer deal.

[15]See. Grossman and Helpman (1994) and references therein.

[16]In fact, pressure groups activities are also ubiquitous, though in different forms, in authoritarian countries. Government commitments are crucial for the success of economic reforms as shown in the country studies collected in Bates and Krueger (1993). For further theories on rent seeking see Yang (1996).

uncertainties interact in negative direction and reduce innovation incentives. Given this commitment problem, innovation incentives are strictly less under intervention compared to the unconstrained free trade situation. Then it is possible that innovation occurs under free trade but licensing occurs under intervention.

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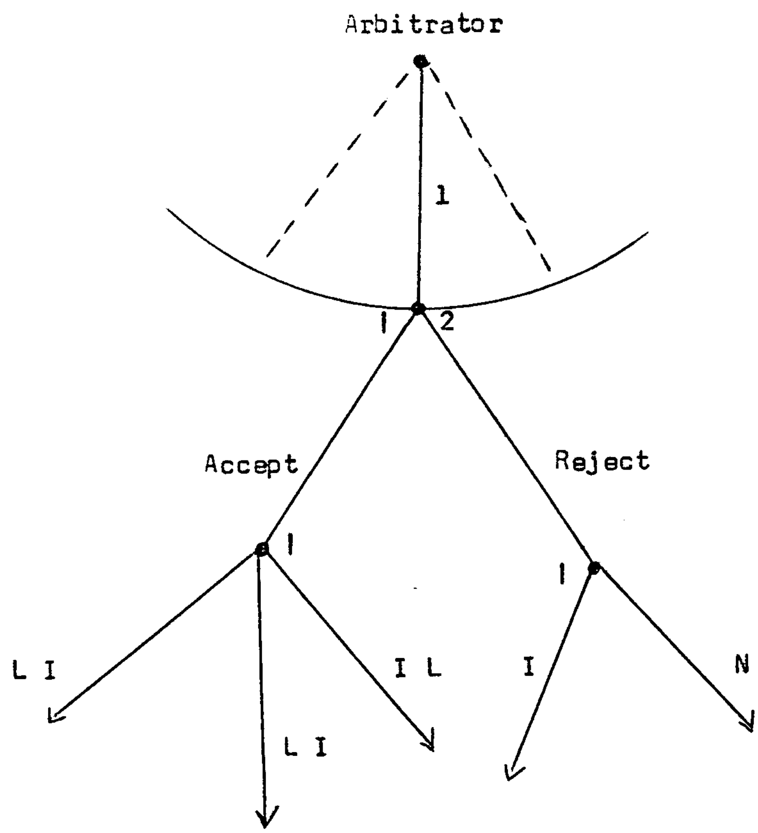

Figure – 1

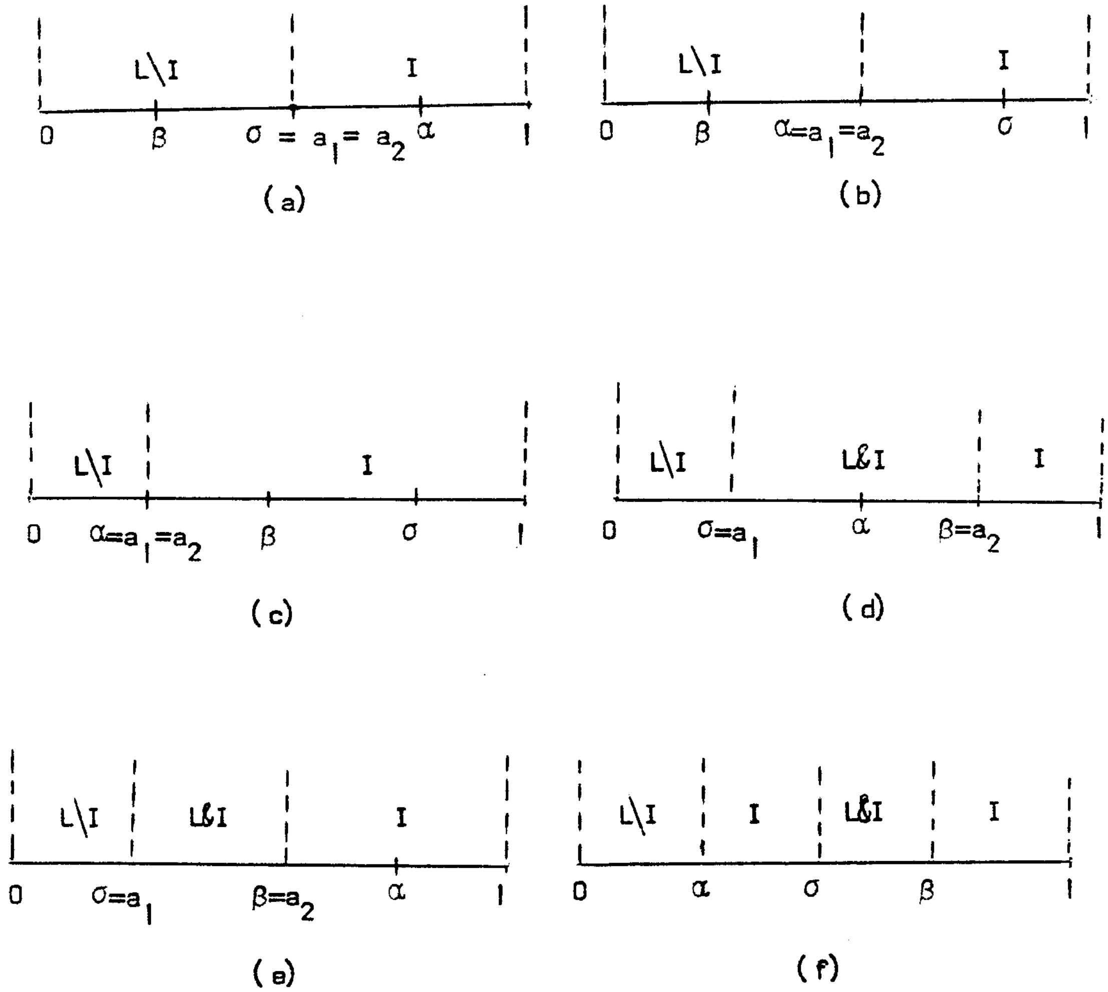
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Figure – 2