KEIO ECONOMIC STUDIES **37**(2), 9–24 (2000)

PROVIDING PROTECTION TO FOREIGN-OWNED PATENTS: A STRATEGIC DECISION

Tarun KABIRAJ

Indian Statistical Institute, Calcutta, India

First version received July 1999; final version accepted July 2000

Abstract: This paper examines the question of whether a non-innovating country will protect foreign-owned patents even when the decision to protect patents does not affect the rate of innovation. We consider a three-country setting, with one innovating north and two imitating southern countries. The non-innovating countries differ in their imitating capabilities and market sizes. We show that the interaction between the imitating countries provides motivation for patent protection. In particular, we find that providing patent protection can be an optimal decision for the more capable imitating country under some conditions.

JEL Classification Number: O34, F23; L14.
Key words: Intellectual property rights; patent protection; innovation; imitation.

1. INTRODUCTION

A unique feature of the Uruguay Round of Multilateral Trade Negotiations under the General Agreement on Tariffs and Trade (GATT) was the inclusion of intellectual property (IP) issues on its agenda. A package of proposals on intellectual property rights (IPRs), popularly known as trade-related intellectual property rights (TRIPs), was offered to all nations on a 'take-it-or-leave-it' basis.[1] This created a commotion among the developing nations. Since most of the innovations occur in the north,[2] the developing countries felt that TRIPs would provide absolute power to the developed nations to rule over the developing countries in future trade and technology matters. Rejecting TRIPs involved threats that countires might be deprived of the benefits of new innovations, along with the threat of cancellation of their GATT membership, and accepting

Acknowledgement. I would like to thank Debraj Ray, Sudipto Dasgupta and the participants of seminars at departments of economics, Utah State University and Jadavpur University for their suggestions and observations on an earlier draft. Comments from an anonymous referee of this journal are gratefully acknowledged. Any remaining errors are my responsibility.

[1] The important policy proposals under TRIPs and their implications to the developing countries are discussed in Kabiraj (1994). For other issues in the Uruguay Round see Greenaway and Sapir (1992).

[2] See Dunning (1994), for instance.

involved loss of welfare due to monopoly pricing in the short run, along with possible long run consequences on their domestic research and development activities. The question was debated for a long time and ultimately the member countries signed the GATT treaty, although grudgingly.

In pressing for extending protection to their IPs, the developed countries argue that inadequate and ineffective protection gives rise to production and trade in counterfeit goods, resulting in losses of sales and exports.[3] They argue that IPRs should be respected so that the private investors who take substantial risks and expenses to develop and commercialize new technologies can get fair returns on their innovations. Otherwise, there will be little incentive for inventive and innovative activity, and this will ultimately impair the interests of all nations.

The existing literature has well recognised the induced effect of IPRs protection on the size and rate of innovations. At issue are those innovations which cannot otherwise be made if the other countries do not extend protection.[4] But it is possible to identify at least a few innovations which may be generated in the north even if the southern countries do not extend patent protection. Assuming that only the northern countries are capable of innovating, the northern markets as a whole are clearly big enough to induce these innovations. To the extent that most of the returns to such innovations originate in the north, extending protection outside the (northern) boundary would not have significant effect on these innovations.[5] In this paper, we concentrate on these innovations which will otherwise occur; we call these "exogeneous" innovations.[6]

Then the question is: Will the innovating north still insist on extending protection for such innovations? If yes, will the southern countries honor northern patents? This paper addresses this last issue. To be more precise, our question is: If innovations are exogeneous, will the non-innovating countries accept the patent proposals of the foreign innovators?

Typically, we believe that a country has a non-trivial decision regarding whether or not to give foreign patent protection, because it believes that the rate of innovation is endogenous (i.e., affected by its decision to protect or not). Then the standard intuition suggests that when there are no endogenous innovation effects, the *dominant* strategy of the south should be *not* to offer protection. The point is further strengthened if there exist many southern countries. Then the chance of each country being "decisive" for innovation decisions comes down, and we have a free-rider problem, with no one giving protection.

[3] See Benko (1987), and in particular, US International Trade Commission (1988).

[4] For example, some innovations have their utility only to some particular countries. So the foreign innovators will never invest on such innovations unless their innovations are protected from imitation in those countries. See Diwan and Rodrik (1991) for a theoretical model on this issue.

[5] See Levin (1980) and Eaton and Kortum (1994).

[6] Thus the present paper addresses only the static effects. Kabiraj and Banerjee (1999) have examined the incentive to honor patent protection in a three-country model when innovations are endogenous. In particular, the paper shows that the patenting decisions of the southern countries depend, among other things, on the imitating capabilities of the south, the length of the patent protection and the R & D technology relevant to the northern firms.

Thus both the assumptions of exogenous innovation and more-than-one southern country separately reinforce the intuitive conjecture that no-protection will be offered, in equilibrium. It is in this context that we address the question of patenting decision of the southern countries. The paper shows that even if innovations are exogenous, providing patent protection by more capable imitating countries can be an optimal decision under some situations. The interaction among the non-innovating countries provides the motivation for patent protection. The literature on IPRs protection has mainly focused on conflicts between northern and southern countries.[7] Almost no analysis has focused on conflicts among southern countries. The purpose of the present paper is to focus on the conflict of interests among southern countries on the question of northern patent protection. The southern countries differ, in particular, with respect to their market sizes and/or capability of imitating foreign technologies. Hence the role of market size and imitative capability in the patenting decision is discussed. We provide the analysis in a three-country setting, with one innovating north and two imitating southern countries.

Generally, an imitating country hurts the innovating country firm both by imitating for domestic markets and by exporting imitations to a third country which either cannot imitate or can imitate only at a later date. Hence we assume that a country, by accepting international patent protection, commits itself not to allow its imitators to either operate in the domestic markets or export imitations to any other countries.[8] In this context we assume the existence of a multilateral forum which is sufficiently empowered to enforce any commitment made by its member countries.

We suppose that the innovating north gives protection to its innovators, and asks the rest of the world to extend similar patent protection for a finite period. The other countries in the rest of the world will decide (simultaneously or sequentially, as may be the ease) whether to honor or dishonor the advanced country's patent laws. We also suppose that selling out the technology and exports of technology-embodied goods are identical. Any country, if at all capable of imitation, can imitate the technology if and only if it has experience with the technology or technology-embodied goods for a certain period.[9] Thus if a country does not extend patent protection, and if its market is served by the innovator, the imitators of the country imitate the technology not only for the domestic market but also for exports to all unpatented markets. The innovator's objective is to maximize profits from the network of world markets, and so there is a possibility that it might not serve the whole world market, because by refusing to serve a particular market it can deprive the respective country of the benefits of consumption and the ability to imitate. This threat is credible because the export of imitations to a

[7] The conflict arises because the firms in the northern countries that develop innovations want to reap the full value of their designs, while the firms in the southern countries want to acquire new technologies at the least cost.

[8] In fact the Uruguay Round of GATT (article 28) prevents third parties from making, using, offering for sale, selling, or importing a patented product without the consent of the innovator.

[9] Northern firm's choice of the optimal mode of technology transfer in the presence of (uncertain) threats of imitation by a southern rival is discussed in Vishwasrao (1994). In particular, the paper assumes that imitation may be possible only if the technology is available through licensing.

third country inflicts losses on the innovating firm in the third market. In the light of this threat the country that can successfully imitate will provide patent protection in order to consume the good.

As a brief overview of the literature closely related to the present work, consider the articles by Chin and Grossman (1991), Maskus (1990), Deardorff (1992), Diwan and Rodrik (1991), Helpman (1993) and Taylor (1994). While all these papers have focused on the north-south conflicts of interests, in none of these models is the issue of conflicting interests among the developing countries on the question of foreign patent protection addressed. Chin and Grossman (1991) provide a north-south model of Cournot duopoly, with all innovations taking place in the north and all imitations occuring immediately in the south at zero cost. The welfare implication of southern protection to northern patent is, in general, ambiguous. Unless northern R&D is expected to result in lowering unit cost of production substantially, the south government, in its interest, might not provide any patent protection, whatsoever.

Maskus (1990) has a dominant-firm competitive fringe structure. Whenever the southern government fails to protect the innovating country's patent, the domestic competitive fringe copies the technology. Such infringement results in lower prices and higher sales in both (segmented) markets. The global welfare change is, however, ambiguous—welfare rises to the extent that the world resource allocation improves, thereby shifting production from higher cost infringers to the lower cost monopoly, but welfare falls because of the introduction of deadweight consumer losses. The Diwan and Rodrik (1991) paper, in contrast, assumes that the north and the south differ in respect of their preferences for certain technologies. If preferences differ widely across regions, the south's incentive to protect northern IP goes up so as to facilitate the invention of technologies 'appropriate' to the south. Similarly, an increase in the relative market size of the south can lead to a reduction in patent protection in both regions.

Deardorff (1992) provides welfare effects of global patent protection when multiple innovations take place in one part of the world, and extending patent protection to additional countries results in lower marginal returns to the innvoator, but there is an increasing cost due to monopoly pricing. Hence from the viewpoint of world welfare, covering the whole world under patent protection is not optimal. Deardorff (1990, 1992) concludes that the poorest countries should be exempted from patent protection. But in the paper there is no separate identity of the countries, and it is also not clear why or why not a particular country should be exempted. In contrast, in our model the southern countries differ with respect to their market sizes and technological capabilities and they decide strategically whether or not to accept patent protection.

While all the papers cited above employ a static partial equilibrium framework, the papers by Helpman (1993) and Taylor (1994) have dynamic general equilibrium setups. Helpman (1993) provides a welfare evaluation of a policy of tighter IPRs by decomposing the welfare change into terms of trade, inter-regional allocation of production, product availability and R&D investment patterns. The paper shows that in the absence of foreign direct investment, both the north and the south benefit from some relaxation of IPRs when the rate of imitation is low; otherwise there is a conflict of interests between the north and the south. But in Taylor (1994), failure to provide patent protection for foreign-made innovations means forcing the innovators to employ less than the best practice research technologies. This reduces aggregate R&D activities worldwide, eliminates technology transfer across countries, and affects worldwide growth adversely.

The set-up of the paper is as follows. The second section describes the analytical framework. The third section provides the model and results of the paper, and the fourth section concludes the paper. An outline of each proof is given in the appendix.

2. ANALYTICAL FRAMEWORK

We consider a three-country framework, with one (technologically advanced) north, N, and two southern (developing) countries, S_1 and S_2, but only the north being capable of innovating new products. We assume that innovations are exogenous, and these will occur only after N has provided patent protection. Let us suppose that the advanced country has provided patent protection to its innovators and now it requests the rest of the world honor its patent laws by extending similar patent protection to the intellectual properties of the innovators for a finite period T, $T < \infty$. Then S_1 and S_2 (i.e., their governments) will unilaterally decide whether to honor (H) the advanced country's patent laws or dishonor (D) by rejecting the proposal. Thus each country has to choose a strategy from $\{H, D\}$. We denote the equilibrium strategies of S_1 and S_2 by X_1 and X_2 respectively.

If a country gives protection to the innovator's invention, the inventor will derive a flow of monopoly profits from that market for the whole duration of the patent period. However, at the end of patent life the market structure becomes competitive, and the flow of profits drops to zero.

We assume that firms in a country can imitate a new technology, provided that the country has had τ years experience with that technology or technology-embodied goods being sold in its domestic market. The period τ may, however, vary by country. Clearly, only the case where $\tau < T$ is of any interest. We also suppose that there is no further cost of imitation.

Generally, an imitating country hurts the innovating country firm by both imitating for domestic markets and by exporting imitations to other countries which cannot imitate or can imitate only at a later date. So we assume that a country, by giving patent protection, can neither imitate for domestic markets, nor can it export imitations to other countries. Hence the innovating firm can refuse to serve markets of a country which may fail to give patent protection, thus depriving of the benefits of consumption and the ability to imitate. On the other hand, if a country does not give patent protection and if its markets are served, once imitation takes place after some time, not only the markets of this country but also the markets of all unpatented countries become competitive, reducing excess profits to zero for all sellers.[10]

[10] Implicitly we are assuming Bertrand price competition. This greatly helps to simplify the payoff expressions in the paper.

Let $X \in \{B, 1, 2\}$ be the sales strategy of the innovator (also to be denoted by N), where B denotes serving both S_1 and S_2 markets, and 1 (2) denotes serving only S_1 (S_2) market (in our analysis serving neither of the markets is always strictly dominated by the other strategies, so that we can ignore it). Hence our problem in the paper is to search the subgame perfect equilibrium strategies (X, X_1, X_2) of N, S_1 and S_2, respectively.

As discussed already, we deliberately consider those situations in which innovations occur in N, regardless of whether S_1 or S_2 gives patent protection. Consider an innovation introducing a new product. Let the demand for the product in an integrated world market be $P(Q)$, with $P'(Q) < 0$, where P is price and Q is the quantity demanded, and the corresponding production cost is cQ, where c is the constant average variable cost of production.

Let θ_j, $j = \{0(N), 1(S_1), 2(S_2)\}$, be the share of the j-th country in the integrated world market; that is, the j-th country's demand function is given by $P(Q; \theta_j)$; $\sum_j \theta_j = 1$. For example, if the demand for the product in an integrated world market is given by the inverse linear demand function

$$P = a - Q, \quad a > c > 0,$$

then the j-th country has the demand function

$$P = a - Q/\theta_j. \tag{2.1}$$

Each country maximizes its own welfare, which we represent as the (discounted) sum of consumer surplus and producer surplus over the life of the product. Let us define $s^0(\theta_j)$ and $s^m(\theta_j)$ as the per period flow of consumer surplus under competitive condition and monopoly respectively, and let $\pi^m(\theta_j)$ be the per period monopoly payoff accrued to the innovator in the j-th market. We further denote

$$\pi_R = \frac{\pi^m(\theta_1)}{\pi^m(\theta_2)} \quad \text{and} \quad s_R = \frac{s^m(\theta_1)}{s^0(\theta_1)}.$$

Since N has already given patent protection, and we are concerned with the patenting decisions of the non-innovating countries, we concentrate on welfare estimates of S_1 and S_2 under different situations (to be described precisely below) subject to the optimal strategies of the northern firm. As we find that discounting does not play any vital role in our paper, except to keep the present values finite, we conveniently assume a zero discounting rate, but a definite date of obsolescence, T', $T < T' < \infty$, for each innovation.

Let $w^j(t)$ denote overall welfare of the j-th country, $j = 1, 2$, over the life of the product such that welfare accrues in the form of consumer surplus at a rate $s^m(\theta_j)$ per period upto t, $0 \leq t \leq T$, and thereafter at a rate $s^0(\theta_j)$ (upto period T'). Thus

$$w^j(t) = ts^m(\theta_j) + (T' - t)s^0(\theta_j). \tag{2.2}$$

The game in our analysis starts at a level where we know that innovations are exogenous (after protection by the innovating country), and the innovating country seeks patent protection from the rest of the world. Now, in the first stage of the game, the governments of the imitating countries decide whether or not to honor the patent of the innovator.[11] Then in the second stage, the innovator-cum-producer decides its sales strategy, that is, whether or not to sell its products to each imitating country. The imitating countries, while choosing their decisions optimally, will internalize the second stage behavior of the innovator. Hence we characterize the subgame perfect equilibrium of the game and describe the optimal strategies, at each stage of the game, of the respective players. We consider both the cases of simultaneous decisions and sequential decisions of the southern countries. Conveniently, we assume that if N is indifferent between serving both the markets and only one market, it will serve both the markets.

We describe the equilibrium strategy choice of each of N, S_1 and S_2 under the following parametric situations. First, we consider the case when the countries are capable of imitating foreign technologies at the same date. That is,

$$\text{(Case 1)} \qquad \tau_1 = \tau_2 \equiv \tau < T\,.$$

Next we consider the case when they have different dates of imitation. Without loss of generality we assume $\tau_1 < \tau_2$, i.e., country S_1 can imitate at an earlier date than country S_2. Then we have two possibilities:

$$\text{(Case 2)} \qquad \tau_1 < \tau_2 < T$$

i.e., each southern country is capable of imitating before expiration of the patent, although S_1 imitates earlier than S_2. Finally we consider the case where

$$\text{(Case 3)} \qquad \tau_1 < T \leq \tau_2$$

that is, effectively, only S_1 can imitate.

Now depending on the strateies of N, S_1 and S_2, the payoffs to the innovator in the i-th case will be denoted by $\Pi_i(X, X_1, X_2)$ and the best response of the innovator (in the second stage game) against a pair of imitators' strategies, X_1 and X_2, will be denoted by $R(X_1, X_2)$.

Supressing the innovator's strategy we denote $W_i^j(X_1, X_2)$ as the social welfare of the j-th country under the i-th case. Then, as we see below, the market of the southern country which extends patent protection is necessarily served. Also the market of the less capable imitating country must be served, irrespective of its decision regarding northern patent protection. Hence we have,

$$\begin{aligned} W_i^1(H,\cdot) &= w^1(T)\,, & W_i^2(\cdot, H) &= w^2(T)\,, \\ W_i^1(D,H) &= w^1(\tau_1)\,, & W_i^2(H,D) &= w^2(\tau_2)\,. \end{aligned} \tag{2.3}$$

The values of $W_i^j(D, D)$ will, however, depend on whether S_1 market is served or not and on the dates of imitation.[12] This we discuss in an appropriate place.

[11] Since we prepare the paper within the framework of GATT rules, we have assumed an uniform patent length for all countries. However, in academic research it is perfectly possible to think of a problem with discriminatory patent policies. This we have not targeted in the present paper. An analysis of the discriminatory standard for IP protection can be found in Aoki and Prusa (1993).

[12] A little thought reveals that in our structure S_2 market will always be served by the innovator.

3. MODEL AND RESULTS

As a benchmark case let us first suppose that there exists only one southern country, S. Then it is easy to understand that if the innovations by the north are exogenous, the southern country does not have any incentive to protect the northern patent. Since the R&D incentive effect is absent under exogenous innovation, the northern firm will always serve the southern country market, irrespective of the latter's policy decision regarding patenting or not patenting the northern innovation, and hence the southern country will never extend protection. In the following analysis we portray the cases when a southern country will extend protection if there exists more than one southern country, although the R&D incentive effect is absent. This focuses our attention on the point that the interaction among the non-innovating countries may provide the unilateral incentive for patent protection.

CASE 1. $\tau_1 = \tau_2 \equiv \tau$

Let us first consider the case when all countries are capable of imitating at the same date.[13] So any unpatented country which gets the technology will imitate the technology at date τ for its domestic market as well as for all foreign markets not under patent laws. In that sense in the absence of strong patent protection knowledge leaks out from one country to other countries, and there is a free-riding problem associated with any such innovation. This yields the following proposition:

PROPOSITION 1. *Given that innovations are exogenous, if all countries have the capability of imitating foreign technologies at the same date, then no imitating country will extend protection to northern patents, and the innovator will serve both the southern markets.*

The unique subgame perfect equilibrium of this two stage game is $(X, X_1, X_2) = (B, D, D)$ (see Appendix 1). This is a very standard and intuitive result. Since innovations are exogenous and all countries have the same date of imitation, we must understand that the innovator will, in this case, serve all countries, irrespective of whether or not countries have provided patent protection. Obviously, when no country accepts patent protection, all the countries are served, because serving no country brings zero profits to the innovator from the rest of the world, and serving at least one country means that all other countries will free-ride after the former country imitates the knowledge; then why will the innovator deprive itself of the profit that it could otherwise make from the other markets before imitation takes place? When one country gives protection, its market is obviously served, but again the other country markets will be served even if it does not provide protection.[14] Knowing this chain of reasoning, it follows that no-protection is the dominant strategy for each country in this game. In fact whether the

[13] Note that the innovating country has already given patent protection; hence its imitators can neither operate in the home country, nor can export imitations to the non-innovating countries.

[14] By giving protection, the j-th country has necessarily a welfare level $w^j(T)$; if it does not provide protection and if its market is not served by the innovator, then its welfare would be $w^j(T) - Ts^m$. Although $w^j(T) > w^j(T) - Ts^m$, not serving its market is not credible once it has chosen no-protection.

southern countries are taking their decisions simultaneously or sequentially, it does not matter, no-protection remains the optimal decision for each country.

We further like to emphasize that the result holds for any number of imitating countries, and it does not depend at all on the size of markets of different countries. This result also indicates that to discuss the possibility of patenting by some countries, we have to assume different dates of imitation.

CASE 2. $\tau_1 < \tau_2 < T$

In this case both southern countries are capable of imitating, but S_1 can do it at an earlier date. We have the following proposition:

PROPOSITION 2. *Assume that innovation is exogenous and the first southern country is the faster imitator (i.e., $\tau_1 < \tau_2 < T$). The subgame perfect equilibrium of this game is characterized as follows: The equilibrium policy pair for the imitating countries is $(X_1, X_2) = (H, D)$ if $\tau_2 > \max[(1+\pi_R)\tau_1, (1-s_R)T]$, otherwise $(X_1, X_2) = (D, D)$; and for the innovator, $X = 2$ if $\tau_2 > (1+\pi_R)\tau_1$ and the first stage outcome is (D, D), otherwise $X = B$.*

The proposition tells that the equilibrium policy pair is for only the first southern country to honor the northern country's patents iff the second southern country is sufficiently impaired at imitation, otherwise, both southern countries choose dishonor. The threat of not serving the faster imitating country is credible when $\tau_2 > (1+\pi_R)\tau_1$.

With linear demand example, as is given by equation (1), we have: $\pi_R = \frac{\theta_1}{\theta_2}$ and $s_R = \frac{1}{4}$. Our results hold irrespective of whether the southern countries decide their policy choices simultaneously or sequentially; also it does not matter which imitating country moves first. An outline of the proof is given in Appendix 2. Here we provide an intuition of the result.

Since S_2 is the late imitator, it knows that its market must be served even when S_1 market is not served. If S_2 does not give protection it can imitate at τ_2 whenever S_1 gives protection. If S_1 does not give protection, but its market is served, S_2 can free-ride with S_1 after τ_1; if S_1 is not served, then, of course, S_2 imitates at τ_2. But accepting patent protection means that S_2 will have to wait for the whole patent period. Therefore, D (i.e., no-protection) is clearly a dominant strategy for S_2, and S_2 must choose D. Now given that S_2 chooses D, whether S_1 will choose H or D depends on whether its market is served or not, which in turn depends on the market sizes and imitating dates. If S_1 would choose H, its market is necessarily served, but if S_1 would choose D, its market may not be served, because by serving S_1, the innovator receives a loss of profits in S_2 market for $(\tau_2 - \tau_1)$ periods, and by not serving S_1, the innovator again has to incur a loss of profits from S_1 market for first τ_1 years. So if either S_1 market is very large relative to S_2 market, or if the imitating dates (τ_1 and τ_2) are very close, not serving the S_1 market cannot be optimal, i.e., the threat of S_1 market being not served is not credible. In that case S_1 must dishonor northern patent laws. Again, when the threat of not serving is credible, S_1 may choose D optimally if its welfare from D is larger than that from H. This is possible if the difference between τ_2 and T is much larger, because by accepting H, the country, S_1, will have to incur a deadweight loss for the whole patent period, T, whereas by not accepting patent laws (D) it will have to incur a loss of consumer surplus for τ_2 period at which it will free-ride with S_2. Only when the distance between τ_1 and T is very large so that the choice of D by S_1 means that its market is not served and in that case it has to incur a larger loss of welfare, its optimal decision is to accept northern patent laws.[15]

CASE 3. $\tau_1 < T \leq \tau_2$

This is the case when effectively only S_1 can imitate. Here the innovators as such face no direct threat of competition from S_2; however, to the extent S_1's decision depends on S_2's, northern firms are indirectly affected by the decision S_2 is taking.

PROPOSITION 3. *Given $\tau_1 < T \leq \tau_2$ and exogenous innovation, (a) if $T \leq (1+\pi_R)\tau_1$, the unique subgame perfect equlibrium is $(X, X_1, X_2) = (B, D, D)$, but (b) if $T > (1+\pi_R)\tau_1$, the subgame perfect equlibrium is described by the following strategies: for the innovator, $X = 2$ if the first stage outcome is (D, D), otherwise $X = B$; and for the southern countries, the equlibrium choice is either (H, D) or (D, H).*

The proposition defines an unique equlibrium outcome, (B, D, D) when the distance between τ_1 and T is small. When the distance is larger, that is, when the only imitating country is capable to imitate at an early date, there are two equilibrium outcomes of the game, viz., (B, H, D) and (B, D, H). An outline of the proof is given in Appendix 3. The analysis of the first part of the above proposition is exactly the same as in the previous proposition. For S_2, D remains to be the dominant strategy. Given that S_2 chooses D, if the distance between τ_1 and T is small, the innovator continues to serve S_1 market even if the country does not provide patent protection. Then D is also the dominant strategy for S_1. Even if the countries decide their policies sequentially, (D, D) remains to be the unique equilibrium for the southern countries. The innovator's optimal strategy is to serve both southern markets irrespective of the decisions of the southern countries.

However, when the distance between τ_1 and T is very large, not serving country S_1 becomes optimal for the innovator when S_1 fails to extend patent protection. Since country S_2 cannot, in fact, imitate before the patent is expired, S_1 has nothing to free-ride but only to deprive the country of the benefits of consumption that it would otherwise obtain by giving protection. Again, S_2 also cannot free-ride anything if S_1 market

[15] In the text we have implicitly assumed that the innovator will introduce the good to a country either from the beginning of the patent period or never. Now suppose that when no country gives protection, goods may be introduced, if profitable, at a later date to delay knowledge flows. In particular in this case (i.e. $\tau_1 < \tau_2 < T$) suppose that the northern firm enters the S_1 market at date $(\tau_2 - \tau_1)$, but S_2 market at date 0. Then, under this 'delayed entry' strategy, not only the innovating firm gets larger profits compared to serving only S_2 markets, but also it has larger profits than serving both countries from the date 0, because by doing this the innovator prevents free-riding of S_2 at date τ_1. Under the 'delayed entry' strategy of the innovator, country S_1 suffers a loss of consumer surplus for the first $(\tau_2 - \tau_1)$ period. Under this situation, its welfare level is $\hat{W}_2^1(D, D) = w^1(\tau_1) - (\tau_2 - \tau_1)s^0$. Hence country S_1's optimal decision will be H if and only if $W_2^1(H, D) > \hat{W}_2^1(D, D) \Leftrightarrow \frac{T-\tau_1}{T-\tau_2} > \frac{s^0(\theta_1)}{s^m(\theta_1)}$.

is not served. Thus S_2 is just indifferent between protection and no-protection, but against H of S_2, S_1's optimal decision is D, because in this case not-serving its market is not credible, and against D of S_2, the optimal decision of S_1 must be H, because otherwise its market will not be served. Hence the equilibrium strategy pairs of S_1 and S_2 in a simultaneous move game are $(X_1, X_2) = (H, D)$ and $(X_1, X_2) = (D, H)$. In this case innovator's optimal strategy is to serve only the second market if the first stage choice be (D, D), otherwise serve both markets.

To solve the multi-equilibria problem, let us introduce S_1's belief regarding the choice of decision of S_2. Let us suppose that S_1 believes that S_2 will choose H with probability $\alpha, 0 < \alpha < 1$. Then we can write the following result.

CORROLARY 1. *Given* $T > (1+\pi_R)\tau_1$, *country* S_1 *will choose* H *if* $\alpha < \bar{\alpha}$, *where* $\bar{\alpha} = \frac{Ts^m(\theta_1)}{\tau_1 s^m(\theta_1)+(T-\tau_1)s^0(\theta_1)}$.

This simply tells that choosing protection by country S_2 with low probability induces country S_1 to give protection. Alternatively, H may be chosen by S_1 if it behaves pessimistically and maximizes its security payoff by means of 'maximin principle'.

Although we are not modeling the case of cooperation between or among the players, a preplay chit-chat talk between S_1 and S_2 can, however, easily solve the multiplicity problem. In this particular case, as we have already noted, S_2 is indifferent between H and D. But the decision of S_2 affects the choice and welfare of S_1. From the viewpoint of S_1, the strategy pair (D, H) is preferred to $(H, .)$ which is preferred to (D, D). So S_1 will try to induce S_2 for choosing H. Since S_2 has nothing to gain on defection, S_2 can accept S_1's request, and in that case S_1 will choose D; hence one possible outcome of the game in our structure is $(X_1, X_2) = (D, H)$.[16]

Before we conclude this section let us study the effect on patenting decision of non-innovating countries when the imitative capability or market size of any country undergoes a change. Consider those parametric situations where the equilibrium outcome is $(X_1, X_2) = (H, D)$. Then we have following observations:

OBSERVATION 1. *As the imitative capability of the later imitating country improves, the earlier imitating country's decision in favour of patent protection becomes weaker.*

The intuition for the result is simple. As τ_2 falls, the strategy D becomes more and more lucrative to S_1, because its expected welfare gain after τ_2 becomes larger.

OBSERVATION 2. *If the market size of the more capable imitating country goes up, it tends to switch over to D.*

[16] If we allow interaction of all the three countries together and introduce side payments, then in this particular case N and S_1 have opposing interests in a sense that inducing S_2 by S_1 to play H affects N's profit adversely, and hence N will also try to persuade S_2 for not playing H. The maximum that N can compensate to S_2 for not playing H is $\Pi_3(H, D) - \Pi_3(D, H)$, and similarly, the maximum that S_1 can make side payments to S_2 for playing H is $W_3^1(D, H) - W_3^1(H, D)$. In our structure we have $W_3^1(D, H) - W_3^1(H, D) > \Pi_3(H, D) - \Pi_3(D, H)$.

The underlying economic reason is that as S_1's market size becomes relatively large, serving its market becomes profitable to the innovating north even when S_1 chooses D, and so S_1 will choose D.

4. CONCLUSION

The inclusion of IPRs within the ambit of GATT has been one of the most debated issues in the recent years. Neither the World Intellectual Property Organization nor the Paris Convention has insisted on formulating uniform patent policies all over the world. So countries had the flexibility to formulate their own patent laws depending on their educational level, technical skill, factor endowment, entrepreneurial ability and the level of economic development. This convention, however, was overturned with the inclusion of IP issues under GATT. Whether it is welfare enhancing or not to bring IP issues within GATT is not settled yet. But to understand the issue it is important to identify the factors which affect the decision to accept or reject the international patent protection.

In this paper we have constructed a simple game-theoretic model to focus on the conflicting interests of the non-innovating countries on the question of extending international patent protection. We have considered only those innovations which occur independent of the extent of patent protection outside the innovating country. We have shown how patent law interests of the non-innovating countries vary depending on the degree of imitative capability and market size of the respective countries. In our paper, the interaction between the two non-innovating countries provides the motivation for patent protection. In particular, we have shown that there are situations where providing patent protection can be an optimal decision for some countries.

The decision to protect patents is prompted by the following consideration: The imitating country hurts the innovating country firms by both imitating for domestic markets and by exporting imitations to countries which cannot imitate, or imitate only at a later date. The innovating firms can refuse to serve the markets of the more capable imitating country, thus depriving them of the benefits of consumption and the ability to imitate. This threat is credible because the export of imitations to late-imitating countries inflicts losses on the innovating firms in those markets. In the light of this threat the country that can successfully imitate will provide patent protection in order to consume the good.

The paper generates a few testable hypotheses. For example, if the market sizes of the non-innovating countries do not differ too much, the less capable imitating countries will tend to reject the proposal of international patent protection. The reason is simple—the foreign innovator is not much threatened by these countries, and so the innovator will tend to cover these countries with its new technologies, but the existence of more-capable imitating countries will make the less-capable imitating countries benefit by not choosing northern patent laws. A second hypothesis is that within the class of imitating countries, those with relatively large market size will tend to resist uniform and compulsory laws. Our analysis shows that inasmuch as backward countries cannot imitate anyway, they are not much affected by the new patent rules. But the middle group countries have reason to react, because they are mostly affected by the new GATT rules. The countries which are more capable of doing successful imitative research are more threatened by the punitive actions from the innovating countries, and hence they are likely to resist signing the GATT treaty.[17]

In the context of the present paper we may provide a justification for why the GATT should press for implementing broad-based and stringent patent rules internationally. In Kabiraj (1995), patent protection is defined narrowly—patent protection as commitment to prevent any imitators from competing with the innovating firm in the domestic country alone. This does not preclude imitators from exporting the good to other countries which do not protect patents. Then, obviously the innovating country, in its interest, prevents export of imitations to the rest of the world. But the non-innovating countries have no such incentives, because under narrowly defined patent protection free-riding becomes easier. Under this situation an additional condition is required so that the more-capable imitating country toes with the northern patent laws (see Kabiraj (1995)). But as one can see easily, if the market size of the more capable imitating country is not at least 'less' compared to the other imitating country, the condition becomes unbinding. In that case it does not matter how patent protection is defined—whether narrowly or broadly. But if the market size of the more capable imitating country is far less, it certainly matters, and to protect the interests of the innovators a stringent definition of patent protection is required.

Within the framework of the paper one can relate the size of innovation to the degree of patent protection (Kabiraj and Banerjee (1999)). To the extent non-patenting by a country reduces the size of innovation, the loss of global welfare will be larger. In an extension one can think of a situation where imitation is uncertain. Countries might have the same probability distribution of imitating dates but with different mean. Or, one can assume having a positive imitation cost which varies across countries, and then review the results when the ability to imitate is unrelated to imports of the good to be imitated. These analyses will provide us with a greater understanding of the problem of international patent protection.

5. APPENDICES

Appendix 1

Depending on the strategies of N, S_1 and S_2, the payoffs to the innovator are expressed as:

$$\begin{aligned}\Pi_1(B,H,H) &= T[\pi^m(\theta_1)+\pi^m(\theta_2)]\\ \Pi_1(B,H,D) &= T\pi^m(\theta_1)+\tau\pi^m(\theta_2)\\ \Pi_1(B,D,H) &= \tau\pi^m(\theta_1)+T\pi^m(\theta_2)\end{aligned}$$

[17] Marjit (1994) argues that the application of uniform patent period means that the nations capable of imitating foreign technologies early are more penalized.

$$\Pi_1(B, D, D) = \tau[(\pi^m(\theta_1) + \pi^m(\theta_2)]$$
$$\Pi_1(1, H, H) = \Pi_1(1, H, D) = T\pi^m(\theta_1)$$
$$\Pi_1(1, D, H) = \Pi_1(1, D, D) = \tau\pi^m(\theta_1)$$
$$\Pi_1(2, H, H) = \Pi_1(2, D, H) = T\pi^m(\theta_2)$$
$$\Pi_1(2, H, D) = \Pi_1(1, D, D) = \tau\pi^m(\theta_2)\,.$$

Then comparing the above payoffs, the second stage optimal strategies are

$$R(H, H) = R(H, D) = R(D, H) = R(D, D) = B\,.$$

Now, consider the first stage of the game. Since both imitators recognize the above reaction of the innovator in deciding their strategies, the payoff matrix of the southern countries is given by,

	H	D
H	$w^1(T), w^2(T)$	$w^1(T), w^2(\tau)$
D	$w^1(\tau), w^2(T)$	$w^1(\tau), w^2(\tau)$

Then D is the strict dominant strategy for each country. Hence, $(X, X_1, X_2) = (B, D, D)$.

Appendix 2

In this case the payoffs of the innovator are defined as:

$$\Pi_2(B, H, H) = T[\pi^m(\theta_1) + \pi^m(\theta_2)]$$
$$\Pi_2(B, H, D) = T\pi^m(\theta_1) + \tau_2\pi^m(\theta_2)$$
$$\Pi_2(B, D, H) = \tau_1\pi^m(\theta_1) + T\pi^m(\theta_2)$$
$$\Pi_2(B, D, D) = \tau_1[(\pi^m(\theta_1) + \pi^m(\theta_2)]$$
$$\Pi_2(1, H, H) = \Pi_2(1, H, D) = T\pi^m(\theta_1)$$
$$\Pi_2(1, D, H) = \Pi_2(1, D, D) = \tau_1\pi^m(\theta_1)$$
$$\Pi_2(2, H, H) = \Pi_2(2, D, H) = T\pi^m(\theta_2)$$
$$\Pi_2(2, H, D) = \Pi_2(1, D, D) = \tau_2\pi^m(\theta_2)\,.$$

From the above payoffs, the best response of the innovator is given by

$$R(H, H) = R(H, D) = R(D, H) = B$$

and

$$R(D, D) = \begin{cases} B & \text{if } \tau_2 \leq (1 + \pi_R)\tau_1 \\ 2 & \text{if } \tau_2 > (1 + \pi_R)\tau_1 \end{cases}$$

Now, if $\tau_2 \leq (1 + \pi_R)\tau_1$, all countries are always served. In that case, S_1 and S_2's payoffs are:

	H	D
H	$w^1(T), w^2(T)$	$w^1(T), w^2(\tau_2)$
D	$w^1(\tau_1), w^2(T)$	$w^1(\tau_1), w^2(\tau_1)$

But if $\tau_2 > (1+\pi_R)\tau_1$, the corresponding payoffs are:

	H	D
H	$w^1(T), w^2(T)$	$w^1(T), w^2(\tau_2)$
D	$w^1(\tau_1), w^2(T)$	$(w^1(\tau_2) - \tau_2 s^m(\theta_1)), w^2(\tau_2)$

Therefore, $(X_1, X_2) = (H, D)$ iff $w^1(T) > w^1(\tau_2) - \tau_2 s^m(\theta_1)$, that is,

$$\tau_2 > (1 - s_R)T .$$

Hence, the proposition.

Appendix 3

The payoffs of the innovator corresponding to the strategies of N, S_1 and S_2 are characterized as follows:

$$\Pi_3(B, H, H) = \Pi_3(B, H, D) = T[\pi^m(\theta_1) + \pi^m(\theta_2)]$$
$$\Pi_3(B, D, H) = \tau_1\pi^m(\theta_1) + T\pi^m(\theta_2)$$
$$\Pi_3(B, D, D) = \tau_1[(\pi^m(\theta_1) + \pi^m(\theta_2)]$$
$$\Pi_3(1, H, H) = \Pi_3(1, H, D) = T\pi^m(\theta_1)$$
$$\Pi_3(1, D, H) = \Pi_3(1, D, D) = \tau_1\pi^m(\theta_1)$$
$$\Pi_3(2, H, H) = \Pi_3(2, H, D) = \Pi_3(2, D, H) = \Pi_3(2, D, D) = T\pi^m(\theta_2) .$$

The best response of the innovator is given by

$$R(H, H) = R(H, D) = R(D, H) = B$$

and

$$R(D, D) = \begin{cases} B & \text{if } T \leq (1+\pi_R)\tau_1 \\ 2 & \text{if } T > (1+\pi_R)\tau_1 \end{cases}$$

Recognizing the above reaction of the innovator, the payoff matrix for S_1 and S_2 is given by

	H	D
H	$w^1(T), w^2(T)$	$w^1(T), w^2(T)$
D	$w^1(\tau_1), w^2(T)$	$w^1(\tau_1), w^2(\tau_1)$

if $T \leq (1+\pi_R)\tau_1$, and

	H	D
H	$w^1(T), w^2(T)$	$w^1(T), w^2(T)$
D	$w^1(\tau_1), w^2(T)$	$(w^1(T) - Ts^m(\theta_1)), w^2(T)$

if $T > (1+\pi_R)\tau_1$. Using the fact that $w^j(t)$ is decreasing in t, we can conclude that the subgame perfect equilibrium outcome of this game is $(X, X_1, X_2) = (B, D, D)$ if $T \leq (1+\pi_R)\tau_1$, but the outcome will be either (B, D, H) or (B, H, D) if $T > (1+\pi_R)\tau_1$.

REFERENCES

Aoki, R. and T. J. Prusa, "International Standards of Intellectual Property Protection and R & D Incentives", *Journal of International Economics*, 35 (1993), 251–273.

Benko, R. P., *Protecting Intellectual Property Rights*, American Enterprise Institute, Washington, DC, 1987.

Chin, J. C. and G. M. Grossman, "Intellectual Property Rights and North-South Trade", in R. Jones and A. Krueger, eds., *The Political Economy of International Trade*, Cambridge, MA: Basil Blackwell.

Deardorff, A. V., "Welfare Effects of Global Patent Protection", *Economica*, 59 (1992), 35–51.

Deardorff, A. V., "Should Patent Be Extended to All Developing Countries?", *World Economy*, 13 (1990), 497–508.

Diwan, I. and D. Rodrik, "Patents, Appropriate Technology and North-South Trade", *Journal of International Economics*, 30 (1991), 27–47.

Dunning, J. H., "Multinational Enterprises and the Globalization of Innovative Activity", *Research Policy*, 23 (1994), 67–88.

Eaton, J. and S. Kortum., "International Patenting and Technology Diffusion", *mimeo*. (1994), Boston University.

Greenaway, D. and A. Sapir, "New Issues in the Uruguay Round: Services, TRIMs and TRIPs", *European Economic Review*, 36 (1992), 509–518.

Helpman, E., "Innovation, Imitation, and Intellectual Property Rights", *Econometrica*, 61 (1993), 1247–1280.

Kabiraj, T., "Intellectual Property Rights, TRIPs, and Technology Transfer", *Economic and Political Weekly*, November 19 (1994), 2990–2998.

Kabiraj, T. "To Protect or Not to Protect Foreign-Owned Patents—A Strategic Decision", *IED Discussion Paper No.* 60 (1995), Boston University.

Kabiraj, T. and K. Banerjee, "International Patent Protection: Conflicts of Interests among Southern Countries", mimeo. (1999), Indian Statistical Institute, Calcutta.

Levin, R. C., "A New Look at the Patent System", *American Economic Review*, 76 (1986), 199-202.

Marjit, S., "Trade Related Intellectual Property Rights and GATT—A Theoretical Evaluation", *Economic and Political Weekly*, December 31 (1994), 3327–3332.

Maskus, K. E., "Normative Concerns in the International Protection of Intellectual Property Rights", *World Economy*, 13 (1990), 387–409.

Taylor, M. S., "TRIPs, Trade and Growth", *International Economic Review*, 35 (1994), 361–381.

US International Trade Commission, "Economic Effects of Intellectual Property Right Infringement", *Journal of World Trade Law, Economics, Public Policy*, 22 (1988), 101–104.

Vishwasrao, S., "Intellectual Property Rights and the Mode of Technology Transfer", *Journal of Development Economics*, 44 (1994), 381–402.