Welfare Improving Monopolies: Intellectual Property Rights in a North-South Framework

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Abstract

We investigate the interaction between optimal patent regimes and mergers in a North-South framework where only the Northern country innovates. Patents are perfectly enforced in the North while such provision is typically lacking in the South. Under this scenario, we show that a forming a monopoly(a merger) increases world welfare by reducing the total patent length in both regions, when imitation is feasible and therefore Pareto-dominates the world welfare obtained without the merger (with and without patent harmonization). Thus mergers may constitute an effective way of increasing world welfare without the TRIPS accord.

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Introduction

Intellectual property rights (henceforth, IPR) have been at the center of debate among trade theorists and policy makers since the inclusion of the Trade-Related Aspects of Intellectual Property Rights (henceforth, TRIPS) clause into the purview of World Trade Organization (henceforth, WTO). Wisdom on the structure of the patent regime remains divided among developed and developing countries. Developed nations favor increased protection of their intellectual property on the grounds that stealing rents from innovators is unethical and discourages innovative activity in the long run. Developing countries, on the other hand, argue that stricter IPR result in greater deadweight losses due to market concentration while the rents from stricter IPR go only to developed nations. Further, since developed nations are at an advantage in terms of innovative capacity, stricter IPR protection tacitly tips the balance towards developed nations.

In this paper we analyze the role of mergers on the choice of optimal patent policy in a North-South framework. In our model innovation is carried out only in the North. Further, patents can be perfectly enforced in the North, however, such provisions are absent in the South. The Southern firm lacks the resources to innovate but can successfully imitate the invented product. With this setup, we analyze a two stage game where a central planner chooses patent lengths in both regions to maximize joint welfare in the first stage. In the second stage, the Northern firm decides whether to form a merger (buy out the Southern firm) or compete with it in the Southern market as well as the level of R&D under both scenarios. Once the merger is formed the possibility of imitation vanishes. We show that the total optimal patent length[1] under the merger is shorter than the total optimal patent length obtained without the merger. Further, the world welfare obtained under the merger Pareto-dominates the world welfare obtained

[1] The total patent length is the sum of individual patents obtained in the two regions.

without the merger. Our results are important in two respects: First, we show that laws like TRIPS are not necessary to increase world welfare. In fact, we show that the world welfare under the merger is higher than that obtained under harmonized patents. Second, we show that in a North-South framework a monopoly can improve welfare and reduce total patent lengths. This is because the firm undertakes more R&D under monopoly, thereby reducing the central planner's incentive to increase the patent length (to encourage innovation) as compared to the one obtained without the merger (monopoly). Since the expected of the firms are at least as high, a shorter total patent length under the merger must imply higher world welfare vis-à-vis the world welfare obtained without the merger.

Gilbert and Shapiro (1990) analyze the tradeoffs associated with patent length and breadth. They derive conditions under which the optimal patent is infinite with the scope of the patent adjusting to provide sufficient rewards for innovation. Klemperer (1990) in a similar spirit derives conditions under which infinitely long and narrow as well short-lived and broad patents are optimal. These models investigate the optimal choice of a patent regime from the perspective of a developed nation. Deardorff (1992), Chin and Grossman (1990) analyze the welfare effect of strengthening IPR in a North-South framework. They show that stricter patent protection increases the welfare of the North at the cost of the South and may result in a fall in total welfare. These models, however, do not address the issue of optimal patent lengths.

Gallini (1992) models the choice of optimal patent policy when imitation is costly. She finds that longer patent lengths tend to encourage imitation because it allows the imitator to invent around the patent. As a result, longer patents may not provide the right incentives for innovation. Consequently, optimal patent design inolves short patent lengths and broad patent breadths. Denicolo (1996) also shows similar results. In our model we assume imitation to be

costless and enforcement to be lax, which make the above mentioned reason necessiating shorter patent lengths absent. Further, their analysis (Gallini 1992; Denicolo 1996) is carried out from the perspective of a developed nation, whereas in our model a central planner maximizes global welfare.

Grossman and Lai (2004) develop a model of endogenous innovation. They show that patents tend to be longer in the country that has a larger capacity for conducting R&D provided its market size is at least as large as its trading partner. Further, they show that patent harmonization is neither necessary nor sufficient for global welfare. Wright (2005) also shows similar results in a model with imitation. He further shows that the optimal global patent design may redistribute wealth to the North from the South. As mentioned before, we show that world welfare under harmonization is Pareto-dominated by the world welfare obtained under the merger.

Lapan and Kim (2006), Zigic (1998) find that the South may actually gain from stronger IPR in a North-South framework. Yang and Maskus (2003) in a dynamic general equilibrium model show that stronger IPR protection leads more technological transfer and encourages invention. Mukherjee and Pennings (2004) analyze the role of licensing and technology adoption when there is a threat of imitation. They find that if patents are short lived then the threat of imitation is dissipated so that it leads to immediate adoption. However if patents are long and the cost of imitation is minimal then technology adoption may be delayed by the innovator. In such a situation licensing the technology increases social welfare by eliminating imitation costs and promoting competition. Liao and Wong (2003) investigate the issue of optimal subsidy and IPR protection in a North–South Model where both compete to develop a product. They find that requiring the Southern country to strengthen the IPR without similar restrictions on the North

may hurt the South. The paper is organized as follows. We lay out the model in section 2. In sections 2.1 and 2.2 we analyze the Northern firms R&D choice with and without the merger. Sections 3.1 and 3.2 present the optimal patent choice with and without the merger and the main results of the paper. Section 4 concludes.

2.1. Model

There are two regions in the world, a North and a South, each containing a single firm. R&D is undertaken only in the North.[2] The Northern firm spends a dollar per unit of R&D. The outcome of innovation is stochastic. Patents are perfectly enforced in the North. However, such provisions are lacking in the South. In other words, imitation is possible in the South. In this setup, the Northern firm decides whether to form a merger or compete with the Southern firm selling the imitated product in their domestic market.[3] By forming the merger, the Northern firm ensures that there is no imitation in the South. We analyze a two stage game. In the first stage, a central planner chooses optimal patents for both regions to maximize global welfare. In the second stage the individual firms decide whether to form a merger or not and the Northern firm chooses the respective R&D levels under each scenario. We solve the game by backward induction. In what follows, we lay out the notation and definition of variables. The payoff functions with or without the merger are laid in the next subsections.

Let $P(.)$ be the probability of invention and let R_N^J and R_N denote the R&D effort expended by the Northern firm with and without the merger respectively. Further, let λ_i^J, λ_i be the respective patent length with and without the merger for the i^{th} region ($i =$ North, South) respectively. We assume that $\lambda_i^J, \lambda_i \in [0,1]$, where $\lambda_i^J, \lambda_i = 1$ implies that the patent lengths are

[2] This is because the cost of undertaking key processes of innovation is prohibitively high in the South.
[3] We assume that the Southern firm cannot sell the imitated product back in the North because of stricter IPR regulations in the North.

infinite. Similarly, $\lambda_i^J, \lambda_i = 0$ implies trivial patent lengths. To see this, note that the present discounted value of one dollar for T_i years in the future with a discount rate of one, yields $\lambda_i : T_i \subset \Re_+ \rightarrow [0,1]$.[4] Since the discount rate has no role to play in this paper we set it at unity. We assume that the Northern firm faces a constant marginal cost "c" of producing the good (once it is invented) and sells the product to a population of size α in both markets. The Southern firm, on the other hand, faces a marginal cost of "ct" where "c" is the unit input cost and "t" is the index of IPR enforcement. We assume that $t \in [1,\infty)$. Enforcement is non existent when $t = 1$ which implies that imitation costs are zero.[5,6] Enforcement is perfect when $t \rightarrow \infty$ which implies that the cost of imitation is infinite. Let S^m, $S(t)$ and S^C represent the consumer surplus under monopoly, duopoly and perfect competition per consumer respectively.[7,8] Monopoly profit per consumer is represented by π^m (in both markets). However, in the case of a duopoly in the Southern market (under imitation), profit for the Northern and the Southern firms are given by $\pi^N(t)$ and $\pi^S(t)$ respectively. We assume that the probability function satisfies the following properties; $P(.)\ is\ C^2 with\ P'(.) > 0, P'' < 0, P(0) = 0, P(\infty) = 1, P'(0) = \infty, P'(\infty) = 0, P''' \leq 0$.

2.2 R&D Choice under the Merger:

In order to be a part of the merger agreement both firms' payoffs (expected profits) must be as high as their reservation payoffs, i.e. the payoff they would have received if the merger was

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[4] $\int_0^{T_i} e^{-t}\, dt = (1 - e^{-T_i}) = \lambda_i$. Note that when $T_i = \infty$ then $\lambda_i = 1$ and when $T_i = 0$ then $\lambda_i = 0$.

[5] In such a case the marginal cost of production for the Southern firm is "c".

[6] We assume that there is a single Southern firm. However, our analysis is not affected if we assume that there are many Southern firms imitating the product. This is because the sum of the expected monopoly profits under the merger is greater than the sum of expected oligopoly profits without the merger.

[7] Note that when both firms compete in the Southern market, the consumer surplus depends on the magnitude of "t".

[8] In this model we have assumed that the market becomes perfectly competitive immediately after the expiry of the patent. Our analysis carries through even if we assumed that the market becomes oligopolistic after the expiration of the patent.

not formed. Let V_N^J , V_N represent the payoffs with and without the merger in the North respectively. Similarly we define V_S^J , V_S for the South.

The Northern firm chooses to pay the Southern firm T_1 such that

$$V_N^J = P(R_N^J)[\alpha(\lambda_N^J + \lambda_S^J)\pi^m - T_1] - R_N^J \geq V_N \quad (1)$$

and $V_S^J = P(R_N^J)T_1 \geq V_S$ (2)

We note that "(2)" must hold with equality in equilibrium.

The first order conditions for profit maximization yields:

$$\frac{\partial V_N^J}{\partial R_N^J} = P'(R_N^J)\alpha(\lambda_N^J + \lambda_S^J)\pi^m - 1 = 0 \quad (3)$$

The optimal level of R&D can be expressed as $R_N^{J*} = R_N^J(\lambda_N^J, \lambda_S^J, \alpha)$ (3A)

2.3. R&D Choice without Merger:

Since the innovation is carried out only in the North, the Northern firms pay off is given by $V_N = P(R_N)\alpha[\lambda_N\pi^m + \lambda_S\pi^N(t)] - R_N$ (4)

It is easy to check that that the above problem is strictly concave and therefore an interior solution exists. The first order condition yields:

$$\frac{\partial V_N}{\partial R_N} = P'(R_N)\alpha[\lambda_N\pi^m + \lambda_S\pi^N(t)] - 1 = 0 \quad (4A)$$

The optimal R&D by the Northern firm then can be expressed as $R_N^* = R_N(\lambda_N, \lambda_S, t, \alpha)$. (4B)

Similarly, the Southern firm's payoff is given by

$$V_S = P(R_N^*)\alpha\lambda_S\pi^S(t) \quad (5)$$

Note that the Southern firm's payoff depends on the level of R&D carried out in the North.

3.1 Patent Choice under the Merger:

In this section we analyze the optimal choice of patent length under the merger. The central planner simultaneously chooses the patent length in each region to maximize joint welfare. We assume that the expected profits of the Northern firm in the South goes back to the North. Now we sketch the welfare function of each government.

The Northern welfare is given by the following:

$$W_N^J = P(R_N^{J*})[\alpha S^m \lambda_N^J + \alpha S^C(1-\lambda_N^J) + \alpha(\lambda_N^J + \lambda_S^J)\pi^m - T_1] - R_N^{J*} \quad (6)$$

where as the Southern welfare is given by

$$W_S^J = P(R_N^{J*})[\alpha S^m \lambda_S^J + \alpha S^C(1-\lambda_S^J) + T_1] \quad (7)$$

which can be simplified to using "(2)" to

$$P(R_N^{J*})[\alpha S^m \lambda_S^J + \alpha S^C(1-\lambda_S^J)] + P(R_N^*)\alpha\lambda_S \pi^S(t) \quad (7A)$$

Note that the payment made by the Northern firm to the Southern firm (T_1) depends on the length of the patent when the merger is not formed. However, the choice of the patent length under the merger is independent of T_1. It is easy to check that the above welfare functions are strictly concave in λ_i^J. The first term in "(6)" represents the welfare gains from innovation under the merger while the second term reflects the cost of innovation. The intuition behind "(7A)" is similar except that there is no R&D expenditure in the Southern region. The central planner maximizes global welfare ($W_G^J = W_N^J + W_S^J$) with respect to λ_i^J. The first order conditions of welfare maximization can be expressed, using first order conditions of profit maximization in "(3)", by totally differentiating the joint welfare function with respect to λ_N^J and λ_S^J respectively as follows:

$$P'(R_N^{J*})[\alpha S^m \lambda_N^J + \alpha S^C(1-\lambda_N^J)]\frac{\partial R_N^{J*}}{\partial \lambda_N^J} + P'(R_N^{J*})[\alpha S^m \lambda_S^J + \alpha S^C(1-\lambda_S^J)]\frac{\partial R_N^{J*}}{\partial \lambda_N^J} \quad (7B)$$
$$= P(R_N^{J*})\alpha(S^C - S^m - \pi^m)$$

The first term represents the increase in welfare due to a rise in the probability of innovation in the North with respect to an increase in the Northern patent length while the second term reflects the same in the South; the third term represents the increase in static deadweight loss associated with market concentration in the North. Similarly, we derive the first order conditions of welfare maximization with respect to the Southern patent length which is given by:

$$P'(R_N^{J*})[\alpha S^m \lambda_S^J + \alpha S^C(1-\lambda_S^J)]\frac{\partial R_N^{J*}}{\partial \lambda_S^J} + P'(R_N^{J*})[\alpha S^m \lambda_N^J + \alpha S^C(1-\lambda_N^J)]\frac{\partial R_N^{J*}}{\partial \lambda_S^J} \quad (8A)$$
$$= P(R_N^{J*})\alpha(S^C - S^m - \pi^m)$$

The intuition behind "(8A)" is similar. We note that "(7B)" and "(8A)" are identical and as a result can only be solved to obtain the sum of patent length in both regions under the merger, i.e., $\lambda^{J*} = \lambda_N^{J*} + \lambda_S^{J*}$, which we call the total patent length under the merger.

3.2. Patent choice without the merger:

In this section, we analyze the optimal patent choice when the merger is not formed. We retain the assumption that a central planner maximizes global welfare, ($W_G = W_N + W_S$) i.e., the sum of the individual welfare functions. The individual welfare functions for the North and South respectively are expressed below:

$$W_N = P(R_N^*)[\alpha S^m \lambda_N + \alpha S^C(1-\lambda_N) + \alpha(\lambda_N \pi^m + \lambda_S \pi^N(t))] - R_N^* \quad (9)$$

$$W_S = P(R_N^*)[\alpha S(t)\lambda_S + \alpha S^C(1-\lambda_S) + \alpha \lambda_S \pi^S(t)] \quad (10)$$

Below we write down the first order conditions of welfare maximization, by totally differentiating the joint welfare function with respect to λ_N and λ_S respectively:

$$P'(R_N^*)[\alpha S^m \lambda_N + \alpha S^C(1-\lambda_N)]\frac{\partial R_N^*}{\partial \lambda_N} + P'(R_N^*)[\alpha S(t)\lambda_S + \alpha S^C(1-\lambda_S) + \alpha\lambda_S \pi^S(t)]\frac{\partial R_N^*}{\partial \lambda_N} \quad (11)$$
$$= P(R_N^*)\alpha(S^C - S^m - \pi^m)$$

$$P'(R_N^*)[\alpha S(t)\lambda_S + \alpha S^C(1-\lambda_S) + \alpha\lambda_S \pi^S(t)]\frac{\partial R_N^*}{\partial \lambda_S} + P'(R_N^*)[\alpha S^m \lambda_N + \alpha S^C(1-\lambda_N)]\frac{\partial R_N^*}{\partial \lambda_S} \quad (12)$$
$$= P(R_N^*)\alpha(S^C - S^m - \pi^S(t) - \pi^N(t))$$

The maximization exercise is similar to the one outlined above and carry similar interpretations. The above equations can be rearranged to yield:

$$P'(R_N^*)[\alpha S^m \lambda_N + \alpha S^C(1-\lambda_N) + \alpha S(t)\lambda_S + \alpha S^C(1-\lambda_S) + \alpha\lambda_S \pi^S(t)]\frac{\partial R_N^*}{\partial \lambda_N} \quad (11A)$$
$$= P(R_N^*)\alpha(S^C - S^m - \pi^m)$$

$$P'(R_N^*)[\alpha S(t)\lambda_S + \alpha S^C(1-\lambda_S) + \alpha\lambda_S \pi^S(t) + \alpha S^m \lambda_N + \alpha S^C(1-\lambda_N)]\frac{\partial R_N^*}{\partial \lambda_S} \quad (12A)$$
$$= P(R_N^*)\alpha(S^C - S^m - \pi^S(t) - \pi^N(t))$$

Note that the term inside the square brackets in “(11A)” and “(12A)” are identical. As a consequence, we obtain the sum of the individual patents that obtain in each region without the merger, i.e., $\lambda^* = \lambda_N^* + \lambda_S^*$, which, as before, will be called the total patent length obtained without the merger.

In what follows, we prove that the total patent length obtained under the merger is shorter than that obtained without the merger. Since the expected profits of the firms under the merger are at least as high without it, a shorter total patent length under the merger must imply higher world welfare. These results are stated in proposition 1 and 2. In proposition 3, we show that it always beneficial for the Northern firm to form a merger as long as imitation is feasible. Below we prove the necessary theorem that leads us to our main results.

Theorem 1: If $V_N^J > V_N$ **then** $P(R_N^*) < P(R_N^{J*})$**.**

Proof: Let not, i.e., let $V_N^J > V_N$ but $P(R_N^*) \geq P(R_N^{J*})$ hold.

First, we argue that if $V_N^J > V_N$ then the following must hold. i.e,

$$P(R_N^{J*})[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - P(R_N^*)[\alpha(\lambda_N^*\pi^m + \lambda_S^*\pi^N(t))] > 0 \quad (13)$$

Suppose not, let $P(R_N^{J*})[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - P(R_N^*)[\alpha\lambda_N^*\pi^m + \alpha\lambda_S^*\pi^N(t)] \leq 0$ (13A)

Re-writing the first order conditions of profit maximization "(4A)" and "(3)" we get,

$$P'(R_N)\alpha[\lambda_N\pi^m + \lambda_S\pi^N(t)] = 1 \quad (4C)$$

$$P'(R_N^J)\alpha(\lambda_N^J + \lambda_S^J)\pi^m = 1 \quad (3B)$$

Since $P(R_N^*) \geq P(R_N^{J*})$, we must have $P'(R_N^*) \leq P'(R_N^{J*})$

Therefore we must have $[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - [\alpha\lambda_N^*\pi^m + \alpha\lambda_S^*\pi^N(t)] \leq 0$ (3C)

Then it must be true that the Northern firm can make as much expected profits without merging vis-à-vis merging. By setting $R_N = R_N^{J*}$, therefore we must have,

$$P(R_N^{J*})[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - R_N^{J*} - \{P(R_N^{J*})[\alpha\lambda_N^*\pi^m + \alpha\lambda_S^*\pi^N(t)] - R_N^{J*}\} \leq 0 \quad (13B)$$

Since $R_N = R_N^{J*}$ is not the optimal choice of R&D under no-merging, its expected profits must increase when it chooses $R_N = R_N^*$. As a result we must have $V_N^J \leq V_N$, which is a contradiction.

As a result "(13)" holds. Now consider "(13)"

$$P(R_N^{J*})[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - P(R_N^*)[\alpha(\lambda_N^*\pi^m + \lambda_S^*\pi^N(t))] > 0$$

Setting $R_N^{J*} = R_N^*$ and differentiating with respect to R_N^*, we get

$$P'(R_N^{J*} = R_N^*)[\alpha(\lambda_N^{J*} + \lambda_S^{J*})\pi^m - T_1] - 1 > 0$$

But by the first order conditions of profit maximization under the merger, we must have $P'(R_N^{J*})[\alpha(\lambda_N^{J*}+\lambda_S^{J*})\pi^m - T_1] - 1 = 0$. Since the profit function is strictly concave, $R_N^{J*} > R_N^*$ must hold. Therefore, we must have $P(R_N^*) < P(R_N^{J*})$.

Proposition 1: If $V_N^J > V_N$ then the total patent length under the merger is shorter than that obtained without the merger.

Proof: Consider "(7B)" and "(11A)" noted below, where "(11A)" from equation "(11)" by changing $S(t)$ to S^m and setting $\pi^S(t) = 0$ while keeping λ_i^* and R_N^* unchanged

$$P'(R_N^{J*})[\alpha S^m \lambda_N^J + \alpha S^C(1-\lambda_N^J)]\frac{\partial R_N^{J*}}{\partial \lambda_N^J} + P'(R_N^{J*})[\alpha S^m \lambda_S^J + \alpha S^C(1-\lambda_S^J)]\frac{\partial R_N^{J*}}{\partial \lambda_N^J} \quad (7B)$$
$$= P(R_N^{J*})\alpha(S^C - S^m - \pi^m)$$

$$P'(R_N^*)[\alpha S^m \lambda_N + \alpha S^C(1-\lambda_N)]\frac{\partial R_N^*}{\partial \lambda_N} + P'(R_N^*)[\alpha S^m \lambda_S + \alpha S^C(1-\lambda_S)]\frac{\partial R_N^*}{\partial \lambda_N} \quad (11A)$$
$$= P(R_N^*)\alpha(S^C - S^m - \pi^m)$$

Dividing "{7B)" by "(11A)" and re-arranging terms we obtain

$$\frac{\alpha S^m(\lambda_N^J + \lambda_S^J) + \alpha S^C(2-(\lambda_N^J + \lambda_S^J))}{\alpha S^m(\lambda_N^* + \lambda_S^*) + \alpha S^C(2-(\lambda_N^* + \lambda_S^*))} = \frac{P(R_N^{J*})\alpha(S^C - S^m - \pi^m)}{P(R_N^*)\alpha(S^C - S^m - \pi^m)}\frac{P'(R_N^*)}{P'(R_N^{J*})}\frac{\frac{\partial R_N^*}{\partial \lambda_N^*}}{\frac{\partial R_N^{J*}}{\partial \lambda_N^J}} \quad (14)$$

Plugging in the expression for $\frac{\partial R_N^*}{\partial \lambda_N^*}$ and $\frac{\partial R_N^{J*}}{\partial \lambda_N^J}$ (which are obtained by differentiating "(3A)" and "(4B)" with respect to λ_N^* and λ_N^J respectively) into "(14)" and using the profit maximizing conditions "(3)" and "(4A)" and some algebra, we obtain

$$\frac{\alpha S^m(\lambda_N^J + \lambda_S^J) + \alpha S^C(2-(\lambda_N^J + \lambda_S^J))}{\alpha S^m(\lambda_N^* + \lambda_S^*) + \alpha S^C(2-(\lambda_N^* + \lambda_S^*))} = \frac{P(R_N^{J*})}{P(R_N^*)}\frac{P'(R_N^*)^2}{P'(R_N^{J*})^2}\frac{-P''(R_N^{J*})}{-P''(R_N^*)} \quad (14A)$$

Given our assumption on the probability function, the right hand side of "(14A)" is greater than unity (since $\frac{P(.)(-P''(.))}{P'(.)^2}$ is positively sloped with respect to its argument and $R_N^{J*} > R_N^*$ by theorem 1). As a result, we obtain that $\lambda_N^J + \lambda_S^J < \lambda_N^* + \lambda_S^*$.

Next consider "(11)" and "(11A)". Since the left hand side of "(11)" is greater than the left hand side of "(11A)" the total patent length without the merger must be increased further in equilibrium. As a consequence, our result obtains.

Comment:

The intuition behind the result is as follows: We first note that a patent increases the incentive of a firm to undertake more innovative activity by increasing the return on innovation (by allowing the firm to sell the product exclusively and thereby make higher expected profits). At the margin the central planner equates the marginal benefit of increasing the patent length (captured by the increase in welfare due to higher innovative activity) to the marginal cost of increasing the patent length (captured by the increase in deadweight losses due to market concentration). In our paper, without the merger, patents are enforced perfectly in the North while such provision is lacking in the South. The Southern firm can imitate an invented product and sell it in its domestic market. This reduces the expected profits of the Northern firm. The reduction in expected profit decreases the incentive to invent. As a result, the central planner increases the total patent length to compensate for the loss in expected profits (due to imitation by the Southern firm) and thereby encourage innovation. In comparison, when the merger is formed, the expected profits of the Northern firm increases (compared to the expected profits earned without the merger). This is because the Northern firm now sells the product as a monopoly (upon successful innovation) by buying out the Southern firm as a result the possibility of imitation vanishes. Since expected profits increase, the Northern firm increases its

R&D effort. The rise in R&D increases the probability of innovation. Therefore, with the merger the expected profits of the Northern firm are higher, the Southern firm makes as much profits under the merger as without it and the probability of invention is also higher. As a result, the central planner has a weaker incentive to encourage more R&D by increasing the total patent length. Consequently, the total patent length under the merger is lower than that obtained without the merger.

Proposition 2: The welfare under the merger Pareto-dominates the welfare without the merger (with or without harmonization) if imitation is feasible.

Proof:

Let us first compare the welfare obtained without the merger under harmonization vis-à-vis without harmonization. In equilibrium (without harmonization) the central planner can allocate the total patent length in three ways. In the first case, the patent length in the North is longer than that in the South. In the second case, the patent length in the South is longer than that in the North and the final case where both are distributed equally. Now consider the effect of harmonized patents on welfare as follows:

Case I: The Northern patent is longer than that in the South in equilibrium without harmonization.

Proof: If patent lengths are equalized (harmonized), the total patent length is either too high or too low compared to the optimal. The total patent length is too high if the Southern patent length is increased to make it equal to the Northern patent and too low if the Northern patent length is reduced to make it equal to the Southern patent length. As a result World welfare must be lower under harmonization (without the merger).

Case II: The Northern patent is shorter than that in the South in equilibrium without harmonization.

Proof: Same as above.

Case III: The patent lengths are the same in both regions in equilibrium without harmonization.

Proof: In this case harmonization has no effect on world welfare.

As a result, we note that World welfare (without the merger) without harmonization is at least as high as with harmonization. Let us now compare the world welfare without the merger (without harmonization) vis-à-vis the world welfare under the merger. We note that both firms make at least as much expected profits under the merger as without it. Further, the probability of invention is higher under the merger. From proposition 1, we note that the total patent length obtained under the merger is shorter than that obtained without the merger As a result world welfare under the merger must necessarily Pareto-dominate the world welfare obtained without the merger (without harmonization).[9]

Comment:

The intuition behind the result is as follows: We first note that welfare under harmonized patents is lower than without harmonization, since harmonized patents do not constitute best responses (unless they are equal in equilibrium). As a result world welfare without harmonization, when there the merger is not formed, is at least as high as with patent harmonization. Further, from proposition 1, we have shown that the world welfare under the merger is higher than the world welfare without the merger. This is because expected profits of

[9] In our analysis, we assume that the level of enforcement is exogenously given. Our analysis would go through even if we assumed that the central planner chose an optimum level of enforcement. We note that the welfare obtained under the merger would be equal to the welfare obtained without the merger only when the level of enforcement is perfect (i.e. $t \to \infty$). We can show that the central planner has no incentives to choose perfect over lax enforcement in equilibrium. As a result for all levels of imperfect enforcement in equilibrium the welfare under the merger would be greater than the welfare obtained without the merger (with or without harmonization).

the firms are at least as large with the merger as without. Also, the probability of innovation is higher (because of higher R&D) under the merger. Since the total patent under the merger is shorter than without the merger, world welfare must be higher compared to the world welfare obtained without the merger.

Proposition 3: The Northern firm always gains by merging, i.e. $V_N^J > V_N$ **as long imitation is feasible.**

Proof: First we note that $\forall t \in \Re$, we must have $\pi^m > \pi^n(t) + \pi^s(t)$. Further, the central planner does not have any incentive to reduce the total patent length (under the merger) to a level such that merging is no longer optimal. Because if it did, the northern firm would choose not to merge. As a result, by the theorems stated above, the Northern firm would reduce its R&D and world welfare must fall

Comment:

In the presence of imitation it is always beneficial for the Northern firm to form the merger because it can sell its product as a monopoly under the merger (after buying out the Southern firm) since the possibility of imitation vanishes. Further, the central planner does not have the incentive to reduce the total patent length to a level under which the Northern firm would find merging to be sub-optimal. Because then the Northern firm would reduce its R&D, and as a result, world welfare would fall.

4. Conclusion:

This paper studies the effect of mergers on optimal patent lengths in a two stage game. In the first stage the central planner chooses the patent length. In the second stage the Northern firm chooses whether to form a merger (buy out the Southern firm) or compete with it in its domestic market. By buying the Southern firm out the Northern firm eliminates the possibility of imitation

and operates as a monopoly in both markets. We show that the level of R&D and consequently the probability of invention are higher under the merger. As a result, the central planner has an incentive to reduce the total patent length under the merger than the one obtained without the merger. Consequently, world welfare under the merger is higher than the world welfare obtained without the merger. We note that as long as imitation is feasible, it is always optimal for the Northern firm to form a merger. In fact, we show that the world welfare under the merger Pareto-dominates the world welfare obtained without the merger (with or without harmonization). Thus we show that laws like TRIPS are not needed to increase world welfare where imitation is feasible.

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