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Static Inefficiency of Compulsory Licensing: Quantity vs. Price Competition

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Abstract

A common argument against compulsory licensing of intellectual property maintains that it facilitates the entry of inefficient producers, which may reduce social welfare independently of any effects on R&D incentives. We study the issue in a model where the innovative firm, under the threat of compulsory licensing, react strategically by choosing between quantity and price competition. We show that the risk of a reduction in static welfare due to the entry of highly inefficient firms is avoided if licensing entails a royalty per unit of output and zero fixed fee. The rationale behind this result lies in the fact that compulsory licensing threat works as a disciplining device to improve static social welfare, even when the applicant is a high cost inefficient firm.

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1. INTRODUCTION

The essential facilities doctrine, within the antitrust law, specifies when the owner of an input or factor of production should be mandated to provide access to it at a reasonable price. Broadly speaking, an input is regarded as essential when it is under the control of a monopolist who denies access to a downstream competitor, in a context characterized by the absence of economically viable alternatives, and the market at issue is important for social welfare (Aoki and Small, 2004). As such, the essential facilities doctrine applies directly to the intellectual property, where an obligation to make property available is equivalent to a requirement for compulsory licensing. On the other hand, intellectual property rights are granted in order to promote innovation by conferring the innovator an exclusive right to exclude others from making, using or selling a protected innovation. So, it seems that there is an obvious conflict between the two body of intellectual property and antitrust law, especially when the innovations are drastic.[1] As Gilbert and Shapiro (1996) point out, although in the long run intellectual property rights may favor competition by granting the innovators to be rewarded for their innovative efforts, in practice great tensions arise between intellectual property and antitrust law due to the elusiveness of the long run outcomes.

The trade off between short run social welfare, which may be enhanced by compulsory licensing, and long run welfare, whose level may depend on the strength of intellectual property rights, has been widely discussed in the economics on optimal

[1] An innovation is "drastic" if its pricing is not affected by the threat of competition, that is the innovator can behave as an unrestricted monopolist (Arrow, 1962).

patents.[2] But, leaving aside the dynamic efficiency problem connected with innovation incentives, there is another critical point which has been less studied. This point, raised by Katz and Shapiro (1985) and Gilbert and Shapiro (1996), questions the widespread opinion that licensing always improves welfare in the short run, i.e., that licensing is always efficient from a static point of view. In a duopoly context, the authors found that in some cases static welfare is strictly lowered by licensing. In particular, under Cournot competition this may occur if the entrant firm produces at rather high costs relative to the innovator's ones, although it has access to the innovation.[3] Thus, compulsory licensing may reduce economic efficiency in the short run by facilitating the entry of inefficient producers that partially crowd out the innovators' output. According to the authors, to set the licensing fee is a difficult task for the antitrust agency, as a high licensing fee might keep out firms whose entrance may be efficient, whereas a low fee might worsen short run efficiency.

Bearing in mind the above risks of compulsory licensing, the aim of this paper is to analyze the role that may be played by the threat of compulsory licensing in conditioning patent holder's strategic choices, and the consequences of these choices on static welfare. We present a very simple model where the players are the patent holder of a drastic innovation and a potential licensee with higher post-licensing production costs, competing à la Cournot if licensing occurs. But compulsory licensing may not actually occur in our framework. When threatened by a mandate to license, the patent holder, whose preferred choice lies in the monopolistic exploitation of the patent, compares the profit under Cournot competition with the profit obtainable applying a lower price by which the prospective entrant would be deterred. If the limit-pricing strategy turns out to be dominant, the potential licensee will be dissuaded from applying for a license.

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[2] One strand of this literature reaches the conclusion that compulsory licensing at low price associated with a long life for patent is socially optimal (Tandon, 1982; Gilbert and Shapiro, 1990; Denicolò, 1996).

[3] Not directly related to licensing, but similar in spirit is the conclusion of Lahiri and Ono (1988), according to which by eliminating or impairing minor firms a government can actually increase welfare.

We find that a decrease in static social welfare, in consequence of an inefficient firm being granted a license, can be avoided if licensing envisages a royalty per unit output and no fixed fee. In such circumstances, when the entrant's production costs are sufficiently high to worsen social welfare if entry actually occurs, the patent holder prefers a limit-pricing strategy. On the contrary, compulsory licensing is the preferred choice when the potential licensee present a small cost disadvantage with the patent holder, as in that case an exclusionary strategy would be too expensive. But if the cost differential is small, entry increases social welfare. In conclusion, under pure royalty arrangement compulsory licensing threat might work as a disciplining device to improve short term social welfare.

This outcome is not entirely confirmed under fixed-fee licensing. We show that in this case the threat of compulsory licensing improves static welfare, whatever the cost differential, if the fixed fee is set at a sufficiently low level. But, more generally, there exists a constellation of parameters (fixed fee and cost differential) where the contrary happens. This is due to the fact that the limit-pricing strategy is less attractive under fixed-fee than under royalty licensing.[4]

The paper is organized as follows. In Section 2 the model is presented and the results are drawn. Section 3 is dedicated to some remarks and extensions, and Section 4 concludes.

2. COMPULSORY LICENSING WITH INEFFICIENT ENTRANTS

Let us consider a market in which operates a patent holder, called firm 1, that manages a proprietary technology implying marginal production costs $m_1 = 0$. There is only one potential entrant, labelled firm 2, whose production costs are $m_2 \geq p^M$ when the access to the patented technology is denied, where p^M is the monopolistic price, and

[4] In a different context, Aoki and Small (2004) assert the superiority of compulsory licensing through a royalty with respect to fixed fee licensing.

$m_2 = \varepsilon + \rho$, $\varepsilon \geq 0$, $\rho \geq 0$, $\varepsilon + \rho < p^M$, when the access is permitted at a royalty per unit output ρ. Since in the absence of licensing $m_2 \geq p^M$, i.e. the patented technology is a drastic innovation, voluntary licensing does not occur. On the other hand, firm 1 technology can be viewed as an essential facility: this leaves room for an antitrust intervention, that is for compulsory licensing. However, as Gilbert and Shapiro (1996) point out, compulsory licensing may not improve social welfare even in the short run.

2.1. COMPULSORY LICENSING UNDER COURNOT COMPETITION

To expound the arguments, we begin with the following proposition which extends to the case of licensing a well known result in the oligopoly theory (Lahiri and Ono, 1988).

Proposition 1. Consider a patent holder (firm 1) and a licensee (firm 2) competing à la Cournot in a homogeneous product market with inverse demand $p = \alpha - X$ and constant but differentiated marginal costs $m_1 = 0$ and $m_2 = \varepsilon + \rho$, $\varepsilon \geq 0$, $\rho \geq 0$, $\varepsilon + \rho < p^M = \frac{\alpha}{2}$, where ρ represents the royalty per unit output. Then, the entry of firm 2 enhances welfare if and only if

$$\varepsilon < \min\left[\frac{5\alpha + 2\rho}{22}, \frac{\alpha - 2\rho}{2}\right]. \tag{1}$$

Proof. Cournot duopoly profits, Π_1^D and Π_2^D, and consumer surplus, CS^D, are given by

$$\Pi_1^D = \frac{[\alpha + (\varepsilon + \rho)]^2}{9} + \rho q_2^D, \quad \Pi_2^D = \frac{[\alpha - 2(\varepsilon + \rho)]^2}{9}, \quad CS^D = \frac{[2\alpha - (\varepsilon + \rho)]^2}{18}.$$

where $q_2^D = \frac{\alpha - 2(\varepsilon + \rho)}{3}$ is the output of firm 2. On the other hand, if firm 1 were the unique producer in the market profits and consumer surplus would be

$$\Pi^M = \frac{\alpha^2}{4}, \qquad CS^M = \frac{\alpha^2}{8},$$

respectively. Then, it is easy to see that the entry of firm 2 increases social welfare, that is $\Pi_1^D + \Pi_2^D + CS^D > \Pi^M + CS^M$, if and only if

$$\Phi = \frac{11}{18}(\varepsilon + \rho)^2 - \left(\frac{4}{9}\alpha + \frac{2}{3}\rho\right)(\varepsilon + \rho) + \left(\frac{5}{72}\alpha + \frac{1}{3}\rho\right)\alpha > 0.$$

Some tedious calculations show that there are two levels of $\varepsilon + \rho$ such that $\Phi = 0$: $\varepsilon + \rho = \frac{5\alpha + 24\rho}{22}$ and $\varepsilon + \rho = \frac{\alpha}{2}$. Moreover, for $\varepsilon + \rho = 0$ the quantity Φ is positive. Thus, $\Phi > 0$ if and only if $\varepsilon + \rho < \min\left[\frac{5\alpha + 24\rho}{22}, \frac{\alpha}{2}\right]$, that is if and only if condition (1) holds.■

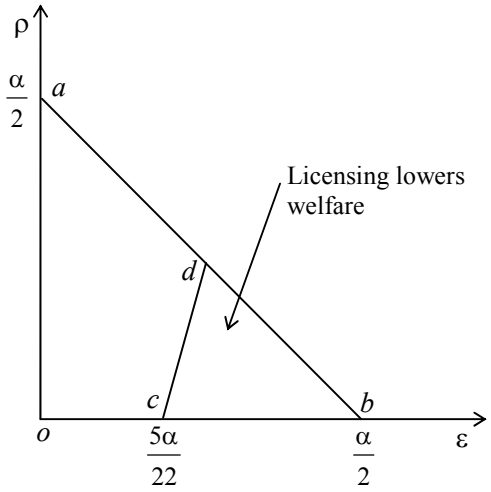

Figure 1. Outcomes under Cournot competition.

Proposition 1 is illustrated in Figure 1. In the region bounded by oab, where $\varepsilon < \frac{\alpha - 2\rho}{2}$, firm 2 applies for a license, because in this region $\Pi_2^D = \frac{[\alpha - 2(\varepsilon + \rho)]^2}{9} > 0$. But in the sub-region bounded by bcd entry decreases social welfare, because there $\frac{5\alpha + 2\rho}{22} < \varepsilon < \frac{\alpha - 2\rho}{2}$.[5] Thus, since production costs of the potential entrant are hardly observed by the antitrust agency and the entrant has the incentives to declare low costs to obtain a license, compulsory licensing may be socially worsening.

2.2. COMPULSORY LICENSING UNDER LIMIT PRICING AND PURE ROYALTY ARRANGEMENT

[5] Proposition 1 parallels the result of Lahiri and Ono (1988) according to which by eliminating minor (inefficient) firms a government can actually enhance social welfare. This occurs because elimination of an inefficient firm shifts production from it to more efficient ones, so that total industry profits increase. Under certain circumstances, the increase in profits dominates the loss in consumer's surplus due to reduction in competition.

The above conclusion ignores a possibility, i.e. that when the cost differential is positive the profits of firm 1 may be greater under price than under quantity competition.[6] Suppose that, although the antitrust agency does not foresee production costs of the potential entrant, these costs are known by firm 1.[7] Moreover, suppose that a post-licensing strategy adopted by firm 1 in order to drive out the licensee would be interpreted as a predatory behaviour by the antitrust authority, while a limit-pricing strategy adopted before firm 2 becomes a licensee does not.[8] In this case, under the threat of compulsory licensing a pre-licensing limit-pricing strategy can be superior to Cournot competition for firm 1. In particular, when production cost of the potential entrant are sufficiently high, instead of passively accepting the antitrust decision and then engaging in Cournot competition with the licensee, firm 1 prefers to set the output price to the level that deters entry.[9]

Proposition 2. Suppose firm 1 is threatened by compulsory licensing at a royalty per unit output ρ. Then, for

$$\frac{\alpha - 2\rho}{5} < \varepsilon < \frac{\alpha - 2\rho}{2} \tag{2}$$

the dominant strategy for firm 1 is the limit-pricing strategy.

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[6] This point has been raised by Zanchettin (2003) in a differentiated duopoly context.

[7] The assumption that post-licensing production costs of firm 2 are foreseen by firm 1 even in the asymmetric case is usual in the literature on voluntary licensing (see, for instance, Katz and Shapiro, 1985).

[8] Under our assumption the term "predatory pricing" refers to a wider range of situations than in the standard legal doctrine and economic models, as it does not imply that in order to drive out rivals active in the market a firm sets the price below its own cost. On this point, see Edlin (2002) and Subsection 3.2 below in this paper.

[9] We first study the consequences of limit pricing under pure royalty licensing. Successively, we will consider the case of a pure fixed fee arrangement.

Proof. The limit price is $p^L = \varepsilon + \rho$. If $p = p^L$ firm 1 profits amount to

$$\Pi^L = [\alpha - (\varepsilon + \rho)](\varepsilon + \rho).$$

On the other hand, if firm 1 accepts the entry of firm 2 by compulsory licensing, its revenue would be

$$\Pi_1^D = \frac{[\alpha + (\varepsilon + \rho)]^2}{9} + \rho q_2^D,$$

where $q_2^D = \frac{\alpha - 2(\varepsilon + \rho)}{3}$. Standard calculations show that $\Pi^L \geq \Pi_1^D$ if and only if

$$\Psi = -\frac{10}{9}(\varepsilon + \rho)^2 + \left(\frac{7}{9}\alpha + \frac{2}{3}\rho\right)(\varepsilon + \rho) - \left(\frac{1}{9}\alpha + \frac{1}{3}\rho\right)\alpha \geq 0.$$

There are two levels of $\varepsilon + \rho$ such that $\Psi = 0$: $\varepsilon + \rho = \frac{\alpha + 3\rho}{5}$ and $\varepsilon + \rho = \frac{\alpha}{2}$. Since for $\varepsilon + \rho = 0$ the quantity Ψ is negative, in the range $\frac{\alpha + 3\rho}{5} \leq \varepsilon + \rho \leq \frac{\alpha}{2}$, that is if condition (2) holds, we have $\Psi \geq 0$. In this range the limit-pricing strategy is optimal for firm 1.■

Obviously, the limit-pricing strategy is dominant for ε sufficiently close to $\frac{\alpha - 2\rho}{2}$ because in this case exclusion of firm 2 does not require a too large reduction in price with respect the monopolistic solution $p^M = \frac{\alpha}{2}$. What is not so obvious is that the level of ε above which the limit-pricing strategy becomes optimal is smaller than the level above which the entry of firm 2 decreases welfare, i.e. that the following proposition holds.

Proposition 3. Suppose firm 1 is threatened by compulsory licensing at a royalty ρ. Then, if firm 1 can choose between quantity and price competition, the threat of compulsory licensing increases social welfare for any significant combination of parameters.

Proof. Recall that under the threat of compulsory licensing the dominant strategy for firm 1 is the limit-pricing strategy when $\varepsilon > \frac{\alpha - 2\rho}{5}$ (Proposition 2), so that in this range compulsory licensing does not occur, but output and social welfare increase with respect to the monopoly solution. On the other hand, for $\varepsilon < \min\left[\frac{5a + 2\rho}{22}, \frac{\alpha - 2\rho}{2}\right]$ the entry of firm 2 enhances social welfare (Proposition 1). Thus, since $\frac{\alpha - 2\rho}{5} < \min\left[\frac{5\alpha + 2\rho}{22}, \frac{\alpha - 2\rho}{2}\right]$, in the significant range $0 \le \varepsilon < \frac{\alpha - 2\rho}{2}$ the threat of compulsory licensing is surely welfare enhancing.■

Figure 2 illustrates our result. In the region bounded by *oadc* the entry of firm 2 increases welfare (see Proposition 1 and Figure 1). In the region bounded by *abe*, where $\varepsilon > \frac{\alpha - 2\rho}{5}$, firm 1 prevents entry by setting the output price to a level that renders negative the entrant's earnings (Proposition 2). Thus, in the region *oae*, included in the region *oadc*, firm 2 enters the market and social welfare increases because the entrant is sufficiently efficient, while in the region *abe* entry does non occur, but compulsory licensing constitutes a threat that leads firm 1 to efficiently produce more output, which enhances welfare.

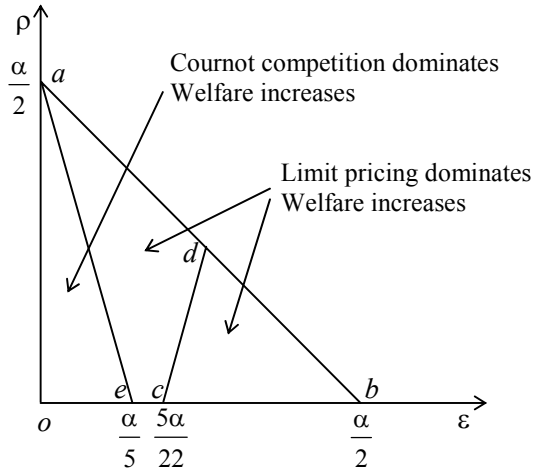

Figure 2. Outcomes with limit pricing.

2.3. PURE FIXED-FEE LICENSING

Suppose now that the antitrust authority mandates access to the patented technology at a fixed fee F and zero royalty. Although a Bain-type model would imply $p^L > \varepsilon$ in this case,[10] in what follows we set $p^L = \varepsilon$ for two reasons. First, a model where $p^L > \varepsilon$ rises a problem of commitment's credibility. Since firm 2 would cover its variable costs and the antitrust authority would oppose a post-entry pricing strategy by the patent holder intended to drive out the newcomer, entry is not completely deterred. In fact, in some cases will be in the interest of the incumbent firm to repudiate its commitment, if entry actually occurs. Second, the simplification $p^L = \varepsilon$ does not compromise the essence of our arguments. With a limit price greater than ε the limit-pricing strategy would simply become dominant on a wider range of the couple (ε, F).

[10] In a Bain-type model (Bain, 1956) the incumbent commits itself to a certain output level which it will maintain in all future periods. If the commitment were credible, $p^L = \varepsilon + 2\sqrt{F}$.

Suppose then that $p^L = \varepsilon$, so that $\Pi^L = (\alpha - \varepsilon)\varepsilon$. The limit-pricing strategy will be weakly dominant for firm 1 if $\Pi^L \geq \Pi_1^D + F$, where $\Pi_1^D = \frac{(\alpha + \varepsilon)^2}{9}$, tat is if

$$\Gamma = -\frac{10}{9}\varepsilon^2 + \frac{7}{9}\alpha\varepsilon - \frac{1}{9}\alpha^2 \geq F .$$

Figure 3 shows the outcomes. In the region bounded by *oab* firm 2 applies for a license, because in this region $\Pi_2^D = \frac{(\alpha - 2\varepsilon)^2}{9} > F$. In the sub-region *cbf*, where $\Gamma > F$, firms 1 adopts a limit-pricing strategy, while in the sub-region *oafc* licensing occurs. The sub-region *oafc* is divided into two zone. In the zone *oaedc* licensing improves welfare, because firm 2 is efficient enough. On the contrary, in the zone *def* licensing is welfare worsening.

Summarizing, we can identify three significant intervals for F. If $F \in [0, F_1]$ the threat of compulsory licensing is surely welfare improving. In these circumstances, if licensing actually occurs it enhances welfare. On the other hand, if licensing were welfare worsening because entrant's production cost are high, the dominant strategy of the incumbent firm would be the limit-pricing strategy, which is welfare improving. Instead, for any $F \in (F_1, F_2)$ there exists a range of the cost differential ε in which licensing actually occurs and welfare decreases due to the inefficiency of firm 2.[11] Finally, for $F \geq F_2$ the entry of a socially inefficient firm is excluded. Comparing these outcomes with those obtained under royalty licensing, where the risk of worsening welfare is

[11] Quite surprisingly, low licensing fees ensure the exclusion of socially inefficient firms, whereas higher fees do not. The reason for this is that higher fees make the limit pricing strategy less advantageous for the patent holder.

entirely avoided, it seems clear that royalty licensing could be the preferred choice by the antitrust agency in all cases in which this arrangement is feasible.[12]

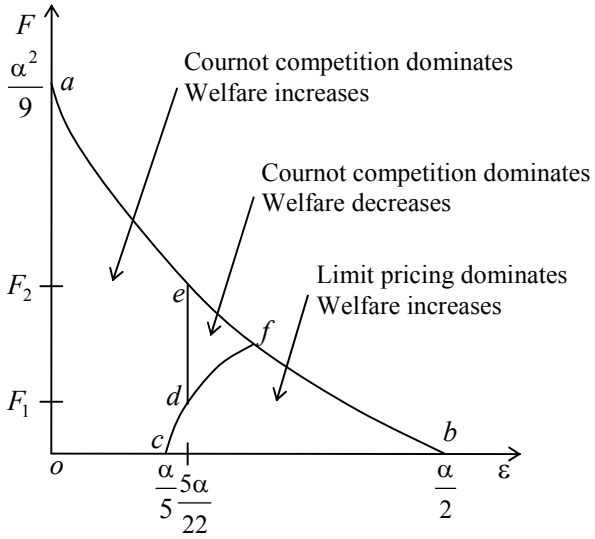

Figure 3. Outcomes with fixed fee.

3. REMARKS AND EXTENSIONS

3.1. COORDINATED PRODUCTION

Besides the case of Cournot competition, Gilbert and Shapiro (1996) consider a situation where the licensor and the licensee coordinate production in order to maximize joint profits. The authors point out that licensing lowers welfare if firm 2's costs are not too high without the license, that is when firms would be reasonably efficient competitors on

[12] The reason for the different outcomes is that an increase in ρ enhances the patent-holder profits under Cournot competition, but also rises the limit-pricing profits (via the effect on p^L), while an increase in F enhances the patent-holder profits under Cournot competition, but leaves unaltered the limit-pricing profits.

their own. In this case, private agreements which tend to restrict production are mutually convenient, but compulsory licensing can be a further source of inefficiency as firms 2 could use it as a threat to extract more favorable licensing terms from firm 1.

If firms have constant marginal costs, coordinated production requires that only the more efficient one will produce, while in more general circumstances, with increasing marginal costs, both firms will produce at positive levels. In any case, since firm 2 has to restrict its output, coordinated production requires some kind of transfer in its favor. For example, a licensing agreement envisaging a rather high royalty and a negative fixed fee can serve the goal. Thus, negative fixed fees and other forms of side payments should be prohibited.

3.2. BELOW-COST PREDATORY PRICING

Recall that our model assumes that the antitrust authority views as predatory any pricing strategy intended to drive out a rival active in the market, even when the involved firm is pricing above its own cost. It is worth noting that this assumption on the antitrust policy is in the spirit of Edlin's proposed above-cost predatory pricing rule (Edlin, 2002), according to which in markets where an incumbent monopoly enjoys significant cost advantages over potential entrants, if entry occurs monopoly should be prevented from responding with substantial price cuts for a time long enough. The author maintains that this rule is a sensible interpretation of section 2 of the Sherman Act and it would give monopolies the incentive to price low in the first place, before entry, because under this interpretation they are not allowed to drive firms from the market after entry. Since it is never clear when an entrant will turn up, the incumbent would have to charge a low price all the time.

Under a more restrictive (and more standard) interpretation of predatory behavior, our results change, but only in part. If the incumbent firm can set the price below the rival cost both before and after entry without incurring in the risk of a legal suit, it no longer has the incentive to price low in the first place, before entry. Thus, the beneficial effect of the limit-pricing strategy induced by the threat of compulsory licensing is lost. However,

the risk of a reduction in social welfare due to the entry of a highly inefficient firm is avoided anyway. When the entrant's cost is high enough to worsen welfare if entry occurs, competing à la Cournot with the entrant is not the preferred choice of the incumbent, as setting the price at the level of entrant's cost is more profitable. Anticipating this, the highly inefficient firm will not apply for a license.

In short, even though Edlin's predatory pricing rule is socially preferable, a more standard rule would not imply the risk that compulsory licensing may reduce social welfare in the short run.

3.3. DYNAMIC EFFICIENCY

While the central point of this paper is the *static* efficiency of compulsory licensing, some remarks on the incentives to innovate are in order. As Gilbert and Shapiro (1996) point out, compulsory licensing likely reduces the incentives to innovate because it reduces the innovator's expected reward and raises the profits of those firms that do not invest in research. Nevertheless, it is important to stress that Gilbert and Shapiro's argument assumes a given patent length, which is natural if compulsory licensing is viewed as an exceptional event, but not if the antitrust agency were using it as a more ordinary action. In this case it would be absurd to ignore that policymakers can also control patent duration, whose lengthening may compensate the negative effects of compulsory licensing on patent holder's earnings. Thus, the problem would turn into the one of coordinating patent and antitrust policies: an antitrust policy inclined to mandate access, given certain circumstances, to patented technologies should be accompanied by a patent regime which guarantees that in those circumstances patent holders enjoy an oligopoly market power for a time long enough to cover research costs. In other words, it is a matter of optimal patent breadth and length, which is not specific of compulsory licensing.[13]

[13] For example, patent breadth may depend on the costs of non infringing duplications as in Gallini (1990) and Maurer and Scotchmer (2002), or on uncertainty and delay in patent litigation, as in Ayres and Klemperer (1999).

Obviously, the effects on social welfare would remain to be seen. Actually, the literature on optimal patents and recent findings on the so-called "ratio test" (Shapiro, 2006a, 2006b; Denicolò and Franzoni, 2006; Cugno and Ottoz, 2006) suggest that compulsory licensing at low price associated with a long life for patent is socially optimal under rather weak conditions on demand and cost functions. But this result has been obtained for the case of numerous potential licensees, each with post-licensing costs equal to the patent holder ones. Considering firms with heterogeneous post-licensing costs, as we have assumed in this paper, would be an interesting extension.

4. CONCLUSIONS

A common argument against compulsory licensing of intellectual property maintains that it facilitates the entry of inefficient producers, which may reduce social welfare independently of any effects on R&D incentives. We have studied the issue in a model where the innovative firm chooses between quantity and price competition, showing that in this case compulsory licensing threat might work as a disciplining device to improve static social welfare, even when the applicant is a high cost inefficient firm.

By compulsory licensing threat we mean a two step policy where the requirement of compulsory licensing is preceded by a formal warning that antitrust authority is determined to intervene after a given time, if the patent holder refuses to grant access to the essential facility. Our main result is that, provided the license entails a royalty per unit of output and no fixed fee, the above policy is welfare enhancing in the short run for any significant combination of parameters. The rationale behind this result lies in the fact that the patent holder under the threat of compulsory licensing reacts in a welfare enhancing way. In case of inefficient potential licensees, giving rise to the static inefficiency problem, the preferred strategy by the patent holder is to lower output price so as to deter the potential entrant from applying for a license. On the other hand compulsory licensing is the preferred choice when potential licensees present a small cost disadvantage with the patent holder, as in that case the exclusionary strategy would be too expensive.

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