# To merge or to license: implications for competition policy*

Ramon Faulí-Oller† and Joel Sandonís‡

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**Abstract**

The optimal competition policy when licensing is an alternative to a merger to transfer a superior technology is derived in a differentiated goods duopoly, for the cases of Cournot and Bertrand competition. We show that whenever both royalties and fixed fees are feasible, mergers should not be allowed, which fits the prescription of the U.S. Horizontal Merger Guidelines. By contrast, when only one instrument is feasible, be it fixed fees or royalties, the possibility of licensing cannot be used as a definitive argument against mergers.

Keywords: merger, patent licensing, competition policy.

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† Universitat d'Alacant. Departament de Fonaments de l'Anàlisi Econòmica. Campus de Sant Vicent. 03071 Alacant. Spain. e-mail: fauli@merlin.fae.ua.es

‡ Corresponding author. Universidad del País Vasco. Departamento de Fundamentos del Análisis Económico. Avd. Lehendakari Aguirre 83. 48015 Bilbao. Spain. e-mail: jepsadij@bs.ehu.es

## 1. Introduction

Mergers and licensing agreements are both important phenomena and have been studied extensively by two separate branches of the economics literature. The articles on mergers have mainly focused on their effect on profits and welfare. Among others, we can mention Williamson (1968), Farrell and Shapiro (1990), Salant et al. (1983) and Deneckere and Davidson (1985). With respect to the licensing literature, it has mainly focused on the optimal form of contracts. Classical examples are Kamien and Tauman (1984, 1986) and Katz and Shapiro (1985, 1986).

However, the theoretical literature has largely overlooked the fact that as means for the transfer of technological knowledge, mergers and licensing are substitutes. This fact is very well known to antitrust practitioners. For example, until 1997, Section 5 of the 1992 U.S. Horizontal Merger Guidelines (HMG), prescribed to forbid mergers whenever the efficiency gains were less than their competitive risks or whenever "equivalent or comparable savings can reasonably be achieved by the parties through other means". In April 1997, however, section 5 on efficiencies was extended to explicitly include among those "other means" the possibility of licensing: "The Agency will consider only those efficiencies...unlikely to be accomplished in the absence of either the proposed merger or another means having comparable anticompetitive effects. These are termed *merger-specific* efficiencies...The agency will not deem efficiencies to be merger specific if they could be preserved by practical alternatives that mitigate competitive concerns, such as...licensing."

The 1997 HMG prescription would be justified if licensing agreements were an efficient instrument to transfer technological knowledge. However, the recent literature has shown that for a variety of reasons licensing may create inefficiencies. Accordingly, the main goal of this paper is to determine which of the two tools is socially preferable.

We compare social welfare under both a merger and a licensing contract in a differentiated goods duopoly for the cases of Cournot and Bertrand competition, in order to derive the optimal competition policy, and check whether that policy fits the prescription of the 1997 HMG. We show that, regardless of the type of competition, whenever both fixed fees and royalties are feasible instruments to license the superior technology, a licensing contract is welfare superior to a merger, which fits the prescription of the 1997 HMG.

Nevertheless, when only one instrument, either fixed fees or royalties, can be used by the patentee, the HMG is shown to be too restrictive because it could lead to forbid welfare improving mergers. In particular, when only a fixed fee is included in the licensing contract,[1] the HMG is too restrictive because, regardless of the type of competition, for close enough substitute goods and large enough innovations, licensing by means of a fixed fee becomes unprofitable for the patentee. In those cases, a merger becomes the only effective instrument to transfer the superior technology and, hence, it should be allowed whenever it is welfare improving. On the other hand, if we consider the case where only royalties are feasible,[2] the patentee sets a greater royalty, distorting even more the licensee's output and thus additionally reducing welfare. In those cases and regardless of the type of competition, for large enough innovations a merger becomes welfare superior to licensing and socially desirable and it should then be allowed.

The remainder of the paper is organized as follows: Section 2 presents the model. Section 3 derives the optimal merger policy for both Cournot and Bertrand competition. Finally, a section with the main conclusions closes the paper. All formal proofs have been relegated to the Appendix.

## 2. The model

We consider two firms, denoted by $i$ = 1,2, each producing a differentiated good (goods 1 and 2 respectively). They face inverse demand functions given by:

$$p_i = 1 - x_i - \gamma x_j, i, j = 1, 2, i \neq j,$$

where $\gamma \in [0, 1]$ represents the degree of product differentiation. Following Singh and Vives

[1] The optimal contract to license a cost reducing innovation to a rival firm includes always a royalty (Faulí-Oller and Sandonís (2002)), provided that the licensee's output is verifiable. Otherwise, royalties are not feasible, which can explain in our context the use of fixed fee contracts.

[2] That situation could arise due, for example, to the existence of a high degree of riskiness associated to the innovation, that precludes the use of fixed fees.

(1984), these demands come from the maximization problem of a representative consumer with utility separable in money ($m$) given by:

$$u(x_1, x_2) = x_1 + x_2 - \frac{x_1^2}{2} - \frac{x_2^2}{2} - \gamma x_1 x_2 + m.$$

The direct demand functions are given by[3]:

$$x_i = \frac{1}{1+\gamma} - \frac{p_i}{1-\gamma^2} + \gamma \frac{p_j}{1-\gamma^2}, i, j = 1, 2, i \neq j.$$

Firm 2 has constant unit production costs of $c$. Firm 1 is assumed to have a patented process innovation that allows to produce good 1 at a lower marginal cost, that we set, without loss of generality, to be zero. Two different mechanisms to transfer the patented technology to firm 2 are considered: a licensing contract and a merger. Both mechanisms are assumed to reduce the marginal cost of producing good 2 to zero[4].

Depending on the size of the innovation we will distinguish between drastic and non-drastic innovations. We will call an innovation drastic when it allows the patentee to monopolize its market. In particular, this is the case if $c \geq c^M$, where $c^M = \frac{2-\gamma}{2}$.

Incorporating the fact that firm 1's marginal cost is assumed to be zero, let us define the social welfare function as:

$$W(x_1, x_2) = u(x_1, x_2) - c_2 x_2,$$

where $c_2 = 0$ if firm 1's technology is transferred and $c_2 = c$ otherwise.

The timing of the game is the following:

[3]Direct demands are not defined for $\gamma = 1$. Therefore, under Bertrand competition, we will restrict the analysis to the case in which the goods are not homogeneous, that is, $\gamma \in [0, 1)$.

[4]Notice that this assumption implies that both instruments allow the perfect and complete transmission of the innovation. In other words, we consider both instruments equivalent from a technological point of view, ignoring problems of asymmetric information between licensor and licensee, as well as the possibility that a merger can create synergies that could give a merger a technological advantage over licensing. Considering licensing and mergers technologically equivalent, while making the analysis tractable, will not significantly affect the qualitative results we obtain. Its main consequence will be that, when deriving the optimal competition policy in this setting, we will never be too permissive with respect to mergers.

In the first stage, the antitrust authority decides whether or not to allow a merger between firms 1 and 2. In the second stage, the firms have the possibility to merge (if allowed in the first stage) or to sign a licensing contract. Given this decision, market competition takes place in the third stage, with the cost functions inherited from the second stage. We will solve by backward induction, obtaining the subgame perfect Nash equilibrium of the proposed game.

We will consider three different licensing scenarios: (1) two-part tariff $(f, r)$ contracts, (2) royalty $(r)$ contracts and (3) fixed fee $(f)$ contracts, where $f$ represents a flat lump-sum license fee and $r$ represents a per unit of output fee (royalty). Scenario 2 could arise for example when riskiness associated to the innovation precludes the use of fees. Scenario 3, when royalties are not feasible due, for example, to lack of verifiability of the licensee's output. Otherwise, scenario 1 arises. The licensing game is modelled as follows: first, the patentee makes a take-it-or-leave-it offer to firm 2; second, this firm accepts or rejects the contract. We do not allow for negative fees because, otherwise, as argued by Katz and Shapiro (1985), contracts would include the possibility for the patent holder to "bribe(s) firm 2 to exit the industry...and would likely be held to be illegal by antitrust authorities."[5] It should be noted that the licensee's marginal cost whenever a royalty is included in the licensing contract (scenarios 1 and 2) is given by $r$ and thus, the patentee plays the role of a leader, as he determines the reaction function of the licensee by deciding the royalty to be included in the contract. On the other hand, under fee licensing (scenario 3) or under a merger, firm 2's marginal cost becomes zero.

Next, we shall proceed to solve the game in order to derive the optimal merger policy under the three possible licensing scenarios. For the two first scenarios we will present together the analysis and the results for both Cournot and Bertrand competition, so that we can easily compare both regimes.

At the third stage of the game, if the firms have merged in the previous stage, the merged entity will produce the monopoly outputs for the two goods. Otherwise, the firms

[5] Notice that we do allow for contracts including negative royalties. Nevertheless, for the case of substitute goods, it is never optimal for the patentee to charge a negative royalty. This would be the case, however, for complementary goods, that are not considered in this work.

will compete either in quantities (Cournot) or in prices (Bertrand), with the marginal costs inherited from the second stage. If no licensing contract has been signed, the status quo will prevail. Under a licensing contract and Cournot competition they solve respectively:

$$Max_{x_1}\{p_1(x_1,x_2)\ x_1 + rx_2\},$$
$$Max_{x_2}\{p_2(x_1,x_2)\ x_2 - rx_2\},$$

where $p_i(x_1, x_2)$, $i = 1, 2$,denotes firm i's inverse demand function.

On the other hand, under Bertrand competition they solve respectively:

$$Max_{p_1}\{p_1x_1(p_1,p_2) + rx_2(p_1,p_2)\},$$
$$Max_{p_2}\{p_2x_2(p_1,p_2) - rx_2(p_1,p_2)\},$$

where $x_i(p_1, p_2)$, $i = 1, 2$, denotes the direct demand functions.

Observe that changing the strategic variable from quantity to price adds an important new effect to the market competition stage: when choosing price, firm 1 considers not only its effect on own market profits but also on firm 2's demand, that determines its royalty revenues. Then, it has an incentive to set a higher price in order to increase firm 2's demand and thus, its royalty revenues. That is, the royalty not only determines firm 2's marginal cost but it also works as a collusive device. Observe that the new effect is absent when firms choose quantities because, in that case, firm 2's demand is not affected by the decision (on output) taken by firm 1. A formal analysis of this effect appears in Faulí-Oller and Sandonís (2002).

The expressions for the third stage Nash equilibrium outputs, prices, profits and total incomes for both types of competition are given below:

For the case of Cournot competition, when firm 2 has accepted a $(f, r)$ contract with

$r \leq c$, they are given by:

$$x_1(r) = \min\{\frac{2-\gamma(1-r)}{4-\gamma^2},\ \tfrac{1}{2}\};\ x_2(r) = \max\{\frac{2(1-r)-\gamma}{4-\gamma^2},\ 0\};$$
$$\pi_1(r) = x_1(r)^2;\ \pi_2(r) = x_2(r)^2;$$
$$\Pi_1(r,f) = \pi_1(r) + r x_2(r) + f;\ \Pi_2(r,f) = \pi_2(r) - f.$$

By substituting $c$ for $r$ in the above expressions, the equilibrium outputs and profits under the status quo situation are obtained. Notice that when firm 2 is not active, firm one produces the monopoly output $x_1 = 1/2$.

Finally, we define industry outputs and profits under a merger. They are given by:

$$x_1^m = x_2^m = \frac{1}{2(1+\gamma)}; \pi^m = \frac{1}{2(1+\gamma)}.$$

For the case of Bertrand competition, let us first analyze the case of non-drastic innovations ($c < c^M$). The third stage Nash equilibrium prices, outputs and profits, when firm 2 has accepted a $(f, r)$ contract are given by:

$$p_1(r) = \frac{(2-\gamma-\gamma^2)+3\gamma r}{4-\gamma^2};\ p_2(r) = \frac{(2-\gamma-\gamma^2)+(2+\gamma^2)r}{4-\gamma^2};$$
$$x_1(r) = \frac{(2+\gamma)-\gamma r(1+\gamma)}{(1+\gamma)(4-\gamma^2)};\ x_2(r) = \frac{(2+\gamma)-2r(1+\gamma)}{(1+\gamma)(4-\gamma^2)};$$
$$\pi_1(r) = p_1(r)\ x_1(r); \pi_2(r) = (p_2(r)-r)\ x_2(r).$$

On the other hand, if no contract is signed the status quo would prevail, which for $c < c^P$, where $c^P = \frac{(2-\gamma-\gamma^2)}{2-\gamma^2}$, leads to the following equilibrium prices, outputs and profits:

$$P_1(c) = \frac{(2-\gamma-\gamma^2)+\gamma c_2}{4-\gamma^2};\ P_2(c) = \frac{(2-\gamma-\gamma^2)+2c_2}{4-\gamma^2};$$
$$X_1(c) = \frac{(2-\gamma-\gamma^2)+\gamma c_2}{4-5\gamma^2+\gamma^4};\ X_2(c) = \frac{(2-\gamma-\gamma^2)-c_2(2-\gamma^2)}{4-5\gamma^2+\gamma^4};$$
$$\Pi_1(c) = P_1(c)\ X_1(c);\ \Pi_2(c) = (P_2(c)-c)\ X_2(c).$$

In that region, both firms are active.

If, on the other hand, $c^P \leq c < c^M$, they are given by:

$$P_1(c) = \frac{(-1+\gamma)+c}{\gamma};\ P_2(c) = c;$$
$$X_1(c) = \frac{1-c}{\gamma};\ X_2(c) = 0;$$

In that region, firm 2 is not active but firm 1 cannot charge the monopoly price.

Finally, for the case of drastic innovations ($c \geq c^M$) the monopoly equilibrium arises and hence $x_1 = p_1 = 1/2$ and $\pi_1 = 1/4$.

In the next three sections the optimal merger policy for the three different scenarios is derived. We start by scenario 1, comparing two-part tariff licensing with a merger.

## 3. Merging vs. two-part tariff licensing

Observe that, if allowed by the antitrust agency, the firms will always choose to merge. On the other hand, as two-part tariff licensing is always profitable for the patentee, if a merger is not allowed, licensing will take place. Intuitively, consider the simple contract $r = c$, $f = 0$. Under Cournot competition, the patentee would obtain the same market profits as in the status quo but the royalty revenues would make him strictly better off. Under Bertrand competition, the collusive effect produced by the royalty would make licensing be even more profitable. Therefore, in order to design the optimal merger policy we have just to compare social welfare under a merger and two-part tariff licensing.

In order to do that, we have first to obtain the optimal two-part tariff licensing contract, that is, the contract that maximizes the patentee's total profits. That contract solves:

$$\max_{r,f}\{\pi_1(r) + rx_2(r) + f\}$$
$$s.t. \quad f \leq \pi_2(r) - \Pi_2(c),$$
$$r \leq c,$$

where $x_i(r)$ and $\pi_i(r)$ denote firm i's equilibrium output and profits under a licensing contract including a royalty $r$, and $\Pi_2(c)$ denotes firm 2's profits in the status quo when its marginal cost is $c$.[6] Observe that the second constraint implies that $f$ cannot be negative.

That program can be rewritten in a simplified way. As the first constraint is always binding, it can be replaced in the objective function. The maximization problem thus becomes:

$$\begin{aligned}&\max_r\{\pi_1(r) + rx_2(r) + \pi_2(r) - \Pi_2(c)\}\\ &s.t. \quad r \leq c.\end{aligned}$$

Solving this program directly results in the optimal contract. For the case of Cournot it is given by:

$$r^* = \min\{c, r'_C\}, \text{ where } r'_C = \frac{\gamma(2-\gamma)^2}{2(4-3\gamma^2)},$$
$$f^* = \pi_2(r^*) - \pi_2(c),$$

and for Bertrand competition by:

$$r^* = \min\{c, r'_B\}, \text{where } r'_B = \frac{\gamma(2+\gamma)^2}{2(4+5\gamma^2)},$$
$$f^* = \pi_2(r^*) - \Pi_2(c).$$

It is important to notice that the optimal two-part tariff licensing contract includes a positive royalty, that distorts the licensee's marginal costs. The patentee uses the royalty to soften ex-post market competition and the fee to extract the increase in the profits of the licensee generated by the use of the superior technology.

Next proposition derives the optimal merger policy for this scenario. Both a merger and the optimal two part tariff contract are anticompetitive. Hence, the sign of the comparison will depend on whether social welfare is affected more negatively by the lower competition induced by a merger or by the distortion of the licensee's marginal cost induced by the licensing contract. The following proposition offers a clear-cut result: regardless of the type of competition, two-part tariff licensing is always welfare superior to a merger.

**Proposition 3.1.** *When two-part tariff licensing contracts are feasible, mergers should never be allowed.*

[6] Notice that under Cournot competition $\pi_2(c) = \Pi_2(c)$ . However, this is not true under Bertrand competition due to the collusive effect of the royalty.

We have two effects at work. However, in the homogeneous goods case ($\gamma = 1$), the sign of the trade-off is clear. Licensing is welfare superior because ouput is greater under duopoly than under monopoly.[7] When the goods are differentiated, the above proposition shows that the result is preserved, namely, that the collusive effect of the merger is greater than the distortion produced by the licensing contract. Interestingly, both instruments become equivalent just in the case where the goods become independent ($\gamma = 0$) because, in that case, the optimal licensing contract does not include a positive royalty but only a fixed fee, leading to the monopoly outputs.

Such a neat result seems intriguing. Therefore, we have checked whether the result crucially depends on the particular assumptions of the model. On the one hand, the result also holds when we generalize the demand functions to take into account asymmetries in the valuation of the goods by the representative consumer.[8]On the other hand, the result also holds if we allow the licensee to have some bargaining power. Notice that if the fixed part of the contract could be negative nothing would change except that the licensee would pay a lower fixed fee (the licensor and the licensee are not interested in reducing the royalty because they want to maximize market profits, so they keep competition low). However, under our assumption of non-negative fixed fees and when the fixed part becomes zero the licensee's bargaining power forces to reduce the royalty even though joint market profits are reduced. But overall the effect is for the contracts to become (weakly) better for society. Therefore, the result of the above proposition would be reinforced.

Observe that the optimal merger policy derived in the proposition fits the prescription of the U.S. Merger Guidelines: when efficiency gains are not merger specific and can also be

[7] Of course they are equivalent in case of a drastic innovation.

[8] We have used inverse demands given by:

$$p_1 = 1 - x_1 - \gamma x_2, \;\; p_2 = a - x_2 - \gamma x_1.$$

They come from the maximization of the utility function:

$$u(x_1, x_2) = x_1 + a x_2 - \frac{x_1^2}{2} - \frac{x_2^2}{2} - \gamma x_1 x_2 + m$$

where the parameters must satisfy the following conditions (Singh and Vives (1984)): $1 - \gamma^2 > 0$, $1 - a\gamma > 0$ and $a - \gamma > 0$.

achieved through licensing, mergers should be forbidden. That result arises in a context in which both fixed fees and royalties are feasible. We will next proceed to derive the optimal competition policy for scenarios 2 and 3 respectively, where only one instrument, either a royalty or a fixed fee, is feasible.

## 4. Merging vs. royalty licensing

The main difference between this scenario and the previous one is that, now, a royalty is the only feasible instrument to license firm 1's patented technology and it has to be used not only to soften ex-post competition but also to appropriate the surplus generated by the superior technology. As a result, a greater royalty will be chosen by the patentee, leading to a greater distortion of the licensee's marginal cost, which opens the possibility that a merger becomes welfare superior to licensing.

The optimal royalty contract solves:

$$\begin{aligned} &\max_r \{\pi_1(r) + r x_2(r)\} \\ &s.t. \quad r \leq c. \end{aligned}$$

Direct resolution of that program results in:

$$r^* = \min\{c, r''_C\}, \text{where } r''_C = \frac{(2-\gamma)(4+2\gamma-\gamma^2)}{2(8-3\gamma^2)} \text{ , and}$$
$$r^* = \min\{c, r''_B\}, \text{ where } r''_B = \frac{8+\gamma^3}{16+2\gamma^2},$$

for Cournot and Bertrand competition respectively. It can be easily verified that the optimal royalties are positive and greater than the corresponding ones in scenario 1, where both royalties and fees were feasible.

Next, we shall proceed to compare a merger and royalty licensing from a social point of view in order to derive the optimal merger policy for this scenario.

**Proposition 4.1.** *When only royalties are feasible, for large enough innovations ($c > c^{ml}$ for Cournot and $c > c^{ml'}$ for Bertrand), mergers should be allowed by the antitrust authority.*

The above proposition states that, regardless of the degree of product differentiation, a threshold value for the size of the innovation exists such that above that threshold a merger becomes at least as good as royalty licensing in terms of welfare. In order to understand the result let us think in the extreme cases. Whereas for the case $\gamma = 1$ (homogeneous goods) a licensing contract is welfare superior to a merger (for both two part-tariff and royalty licensing), when $\gamma = 0$ things change: the optimal licensing contract includes now a positive royalty, given that no fixed fee can be used in this scenario. The royalty distorts firm 2's marginal cost and output, whereas the efficient solution would be (for any given level of aggregate output) the equal split, which is achieved through a merger. In short, when $\gamma = 0$, a merger achieves the transfer of the superior technology without reducing competition whereas licensing becomes anticompetitive due to the presence of a royalty in the contract. As a result, for any size of the innovation, a merger is welfare superior to a licensing contract. However, as the goods become closer substitutes, the threshold values $c^{ml}$ and $c^{ml'}$ increase. The reason is that closer substitutive goods imply more intense competition, which makes a merger relatively more anticompetitive than a licensing contract, thus decreasing the region where mergers should be allowed. It is just in the extreme case $\gamma = 1$ that only for drastic innovations a merger becomes equivalent to a royalty contract whereas for any non-drastic innovation it is welfare inferior.

Notice that when only royalties are feasible for the patentee, the optimal royalty is greater than in the case where both royalties and fees can be used, which negatively affects social welfare. This is why, for large enough innovations and regardless of the type of competition, a merger becomes welfare superior to licensing and, therefore, it should be allowed by the antitrust authorities.

Next, we shall proceed to derive the optimal merger policy in scenario 3, where a fixed fee is the only feasible instrument to license the superior technology.

## 5. Merging vs. fixed fee licensing

Licensing by means of a fixed fee allows the transfer of the superior technology without reducing competition. Therefore, fixed fee licensing is welfare superior to a merger. However, for large enough innovations and close enough substitute goods, licensing by means of a fee becomes unprofitable for the patentee (as shown by Katz and Shapiro (1985) for the case of homogeneous goods, the efficiency gains can be more than compensated by the *rent dissipation effect,* which drives down duopoly profits). In that case, a merger becomes the only effective instrument to transfer the superior technology and, therefore, it should be allowed whenever it increases social welfare relative to the status quo, which tends to occur precisely for large innovations. We will present the results for each type of competition in a separate subsection. While the analysis of licensing profitability follows a similar pattern in both cases, the analysis of the merger policy is much more complex for Bertrand competition and it requires a detailed attention. Let us start by the case of Cournot competition.

### 5.1. Cournot competition

Next lemma characterizes the conditions under which fixed fee licensing is not profitable for the patentee.

**Lemma 5.1.** *Under Cournot competition, if* $\gamma > 0.82$ *and* $c > c^L$*, licensing by means of a fixed fee becomes unprofitable for the patentee.*

The key point to explain the result is that, given that the patentee always binds the licensee's participation constraint through the fixed fee, fixed fee licensing is profitable only if industry profits increase as a consequence of the licensing contract. When the goods are very differentiated, competition is not intense and industry profits increase regardless of the size of the innovation. For the case of close substitutes however, the trade-off between the efficiency effect and the rent dissipation effect becomes relevant. For small innovations, the latter effect is small and it is dominated by the former, given that the improved efficiency is applied over many units of output that would be produced by firm 2 under the status quo. For large innovations however, first, the rent dissipation effect of transferring the innovation is much higher and, second, the improved efficiency is applied to fewer units of output that would be produced by firm 2 under the status quo. As a result, industry profits would decrease, making fixed fee licensing unprofitable for the patentee.

Next lemma establishes the conditions under which a merger is welfare superior to the status quo.

**Lemma 5.2.** *Under Cournot competition, a threshold value $c^{ms}$ always exists such that a merger is welfare improving if and only if $c \geq c^{ms}$.*

The above proposition can be seen as the optimal merger policy when the efficiency gains attained through a merger are *merger specific.* Lahiri and Ono (1988) find that with homogeneous goods the acquisition of small firms increase welfare. The above proposition shows that the same result extends to the case of differentiated goods. Taking into account that $c^{ms}$ increases with $\gamma$, it provides a nice illustration of the trade-off between competition and efficiency involved in a merger. While the size of the anticompetitive effect is inversely related to the degree of product differentiation $\gamma$, the efficiency effect is captured by $c$, the size of the innovation. Therefore, the greater the anticompetitive effect (the greater $\gamma$) the greater the size of the efficiency gain (the greater $c$) required for the merger to be welfare superior to the status quo.

Next proposition combines lemmas 5.1 and 5.2 in order to derive the optimal merger policy.

**Proposition 5.3.** *Under Cournot competition, when only a fixed fee can be included in the licensing contract, if $\gamma \leq 0.82$, a merger should never be allowed; if $\gamma > 0.82$, it should be allowed if and only if $c \geq c^L$.*

The result is driven by the fact that $c^L > c^{ms}$. In other words, in the region where fixed fee licensing is not profitable for the patentee, a merger is welfare improving and it should then be allowed. A direct implication of the proposition is that under the optimal merger policy, technology is always transferred.

Let us derive next the optimal merger policy for scenario 3 under Bertrand competition.

## 5.2. Bertrand competition

Next lemma characterizes the conditions under which fixed fee licensing is not profitable for the patentee.

**Lemma 5.4.** *Under Bertrand competition, if $\gamma > 0.61$ and $c > c^{L'}$, licensing by means of a fixed fee becomes unprofitable for the patentee.*

The intuition for the result is exactly the same as for the case of Cournot competition. The only difference is that, given that Bertrand is a more intense type of competition, we reach the region where licensing is not profitable for the patentee even for lower values of $\gamma$ than for the Cournot case.

Next lemma derives the conditions under which a merger is welfare superior to the status quo.

**Lemma 5.5.** *Under Bertrand competition, three threshold values $c^{ms'}$, $c^{n}$ and $c^{ms''}$, with $c^{ms'} \leq c^{n} < c^{ms''}$ exist such that when $\gamma \leq 0.69$, a merger is welfare superior to the status quo if and only if $c \geq c^{ms'}$, when $0.69 < \gamma \leq 0.71$, if either $c^{ms'} \leq c \leq c^{n}$, or $c \geq c^{ms''}$, and when $\gamma > 0.71$ if and only if $c \geq c^{ms''}$, where the values of $c^{ms}, c^{ms'}$, $c^{n}$ and $c^{ms''}$ are provided in the appendix.*

Observe that except for the intermediate interval $0.69 < \gamma \leq 0.71$, the intuition behind the result is similar to the one obtained for Cournot competition. Namely, mergers should be allowed for large enough innovations such that their efficiency effect outweights their anticompetitive effect. In those cases, the design of the optimal merger policy simply consists of finding the corresponding unique cut-off value. Notice that this cut-off value is higher for the case of Bertrand than for Cournot because competition is more intense in the former (see Vives (1985)).

The previous simple intuition, however, does not work for the intermediate interval in the above proposition. The striking point in that interval is that, as the size of the innovation increases, the optimal merger policy decision switches from approving the merger to forbidding it. This implies that more than one cut-off value is required to completely define the optimal merger policy.

(insert figure 1 here)

Figure 1 plots, for $\gamma = 0.70$, welfare under both a merger (Wm) and the status quo (Wsq) as a function of $c$. While welfare under a merger is constant in $c$, welfare under the status quo follows a more complex pattern: as $c$ increases from zero, good 2 is produced more inefficiently but production is being concentrated on the more efficient firm. For high values of $c$ the latter effect dominates, which explains the increasing part of the function. When $c$ reaches the region where firm 2 does not produce but firm 1 cannot charge the monopoly price, ($c^P \leq c < c^M$), additional increases of $c$ have the only effect of increasing prices, and no efficiency effect is involved, which explains that the function decreases. This decreasing part is what distinguishes Cournot from Bertrand (the fact that, with Cournot competition, welfare may increase when a firm becomes less efficient was already noted by Lahiri and Ono (1988)). Finally, for drastic innovations ($c \geq c^M$), the welfare function is constant in $c$.

The reason why we obtain a unique cut-off value except for the interval $0.69 < \gamma \leq 0.71$ is that outside this interval Wm either lies above the upper line (max) or below the lower line (min) in Figure 1.

Next proposition combines lemmas 5.4 and 5.5 to derive the optimal merger policy for the Bertrand case.

**Proposition 5.6.** *Under Bertrand competition, if* $\gamma \leq 0.61$*, mergers should never be allowed; if* $0.61 \leq \gamma \leq 0.69$*, mergers should be allowed if and only if* $c \geq c^{L'}$*; if* $0.69 < \gamma \leq 0.71$*, if either* $c^{L'} \leq c \leq c^n$ *or* $c \geq c^{ms''}$*; finally, if* $\gamma > 0.71$*, if and only if* $c \geq c^{ms''}$*.*

The above proposition shows first, that in the region where both firms are active ($c < c^P$), mergers should be allowed only for intermediate values of the differentiation parameter (low values of $\gamma$ makes fixed fee licensing always profitable and high values prevent mergers from being socially desirable) and either for large enough innovations (for $0.61 \leq \gamma \leq 0.69$, small innovations prevent mergers from being socially desirable) or for intermediate innovations (for $0.69 < \gamma \leq 0.71$ small and large innovations prevent mergers from being socially desirable). Second, in the region where in absence of licensing firm 2 would not be active ($c \geq c^P$), a new case appears where above a certain threshold value of $c$, mergers should again be allowed (notice that in this region, welfare under the status quo is always decreasing in $c$ because, now, firm 2 is not active and additional increases of $c$ do not transfer any inefficient output to the more efficient firm).

Observe that under Bertrand competition, contrary to what happens under Cournot, the optimal merger policy does not necessarily lead to technology transfer. For example, in figure 1, for innovations lying in the interval ($c^n$, $c^{ms''}$), licensing by a fixed fee is not profitable for the patentee and, at the same time, a merger is not welfare improving, which implies that it should be forbidden. In that interval, the superior technology is not transferred under the optimal merger policy.

Summarizing, from the optimal merger policy derived in Propositions 3.1, 3.2, 3.5 and 3.8, an interesting policy implication can be derived. When licensing is an alternative to a merger for transferring technology, a more restrictive optimal merger policy is called for. This argument seems to be present in the 1997 HMG, that prescribes to forbid mergers whenever the efficiency gains can be alternatively achieved through licensing. The optimal merger policy derived in the paper exactly fits that prescription only when both fixed fees and royalties are feasible instruments to license the superior technology. Otherwise, the possibility of licensing cannot be used as a definitive argument against mergers. In particular, it may be too restrictive because it may lead to forbid welfare improving mergers: in scenario 2, it may occur because the patentee imposes greater royalties that additionally distort the licensee's output, reducing welfare. On the other hand, in scenario 3 because, as Propositions 3.3 and 3.6 show, fixed fee licensing is not always profitable for the patentee and, in those cases, a merger is the only effective instrument to transfer the superior technology.

## 6. Conclusions

The traditional merger policy analysis prescribes to allow a merger if and only if it generates efficiency gains that compensate for their negative impact on competition. In this paper, we extend this analysis by considering also the existence of an alternative mechanism that may allow firms to attain those efficiencies, namely, patent licensing. In that case, a more restrictive merger policy is called for. The 1992 U.S. Horizontal Merger Guidelines was revised in 1997 to incorporate this idea, and it prescribes to forbid mergers whenever efficiency gains are not merger specific, but can also be achieved through licensing. In this work, we have shown that the prescription of the 1997 HMG is too restrictive. In particular, for large innovations mergers tend to be superior to licensing: when royalties are not feasible, it is true because large innovations make licensing unprofitable and, at the same time, make mergers socially desirable; on the other hand, when fixed fees are not feasible, because for large innovations the patentee tends to impose high royalties that distort total output and welfare.

Without considering the possibility of licensing, the traditional merger policy is more restrictive the closer substitutes the goods are, because a merger becomes more anticompetitive. This is still true in our framework whenever royalties are feasible. When only fees are feasible, however, the result is reversed: mergers should be allowed only when the goods are good substitutes. The reason for this counterintuitive result is that what determines the merger policy in that case is whether licensing is profitable or not, and it turns out that it is not profitable when the goods are close substitutes.

So far, we have focused on deriving the optimal merger policy when licensing is an alternative to a merger to transfer technology. An interesting extension of the paper would be to design not only the optimal merger policy but a more general competition policy, in the sense that it also allows us to prescribe whether licensing should be allowed or not. As shown in Faulí-Oller and Sandonís (2002), while under Cournot competition licensing is always welfare improving, under Bertrand competition the royalty works as a collusive device that allows the patentee to increase prices, producing a negative effect on social welfare. As a consequence, for large enough, non-drastic innovations, licensing may reduce social welfare and, thus, it should be forbidden by the antitrust authorities. For example, in scenario 2, we compare a merger and royalty licensing. The optimal merger policy prescribed just to allow the merger whenever it is welfare superior to licensing. However, using that rule, we could be approving welfare reducing mergers. On the other hand, whenever welfare under licensing is higher than under a merger, we should not only forbid mergers but also check whether or not the licensing contract improves social welfare. If that is not the case, we should forbid not only mergers but also licensing.

Another interesting question arising from our results is whether the design of the optimal competition policy always favors technology transfer. The answer is negative. A special case exists where mergers are forbidden even though they are the only effective instrument to transfer the superior technology: when we consider fixed fee contracts, for large enough innovations and close enough substitutes, licensing becomes unprofitable for the patentee and, given that competition is intense, a merger is not welfare improving and it should then be forbidden. In those cases, the optimal competition policy prevents the diffusion of the patented innovation.

In this paper, we assume that a patented process innovation already exists and analyze the incentives of the patentee to transfer the innovation through a licensing contract and also through a merger, and then compare their effect on social welfare in order to design the optimal competition policy. Another interesting extension of the paper would be to go one step backwards and consider also a previous stage in which the firms decide their R&D investments, and then analyze how the incentives of the firms to undertake R&D are affected by different antitrust policies. In that case, in order to design the optimal competition policy we should compare the anticompetitive effect of a merger with both the eventual efficiency gains and the increase in the incentives of the firms to undertake R&D. As a result and compared with our setting, we could prescribe in that case a less severe merger policy.

## 7. Appendix

### Proof of proposition 3.1

Let us denote by $W^m$ and $W^r$ social welfare under a merger and under a licensing contract including a royalty $r$. Under Cournot, we have that $W^m > W^r$ if and only if $r > c^{ml}$, where $c^{ml} = \frac{8-6\gamma^2+2\gamma^3-\sqrt{2(4-\gamma^2)^2(2+4\gamma-\gamma^2-3\gamma^3)}}{2(-4-4\gamma+3\gamma^2+3\gamma^3)}$. As $c^{ml} \geq r'_C$ (the optimal unrestricted royalty) and the royalty chosen by firm 1 is never superior to $r_C$, licensing is always socially preferred to a merger.

Under Bertrand, $W^m > W^r$ if and only if $r > c^{ml'}$, where

$c^{ml'} = \frac{(2+\gamma)(-4+4\gamma^2+2\gamma^3-2\gamma+(2-\gamma)\sqrt{2(2+8\gamma+5\gamma^2+\gamma^3+2\gamma^4)})}{2(4+4\gamma+5\gamma^2+5\gamma^3)}$. As $c^{ml'} \geq r'_B$, licensing is always socially preferred to a merger. ■

### Proof of Proposition 3.2

Under Cournot, $c^{ml} \leq r''_C$ (the optimal unrestricted royalty) and therefore for $c > r^{ml}$ a merger is socially preferred to licensing.

Under Bertrand, $c^{ml'} \leq r_B''$ and therefore for $c > r^{ml'}$ a merger is socially preferred to licensing. ■

## Proof of Proposition 3.3

For Cournot competition, directly comparing industry profits under fixed fee licensing with the status quo situation, we obtain that $\pi_1(0) + \pi_2(0) < \pi_1(c) + \pi_2(c)$ if and only if $\gamma > 0.82$ and $c > c^L$, where $c^L = \dfrac{2(4 - 4\gamma + \gamma^2)}{4 + \gamma^2}$. ■

## Proof of Proposition 3.4

For Cournot competition, comparing welfare under both a merger and the status quo directly produces the result, where $c^{ms} = \frac{-24-8\gamma+18\gamma^2-2\gamma^4+(4-\gamma)\sqrt{2(18-19\gamma^2+\gamma^3+2\gamma^4)}}{2(-12-12\gamma+\gamma^2+\gamma^3)}$. ■

## Proof of Proposition 3.5

Whenever licensing is not privately profitable and mergers are socially preferred to the status quo, mergers should be allowed. This proposition just brings together the corresponding conditions from propositions 3.3 and 3.4, taking into account that $c^L \geq c^{ms}$. ■

## Proof of Proposition 3.6

We have to compare industry profits under fixed fee licensing with the status quo situation in the two relevant cases.

If $c \leq c^P$, $\pi_1(0) + \pi_2(0) < \Pi_1(c) + \Pi_2(c)$ if $\gamma > 0.65$ and $c > c^{L'}$.

If $c > c^P$, $\pi_1(0) + \pi_2(0) < \Pi_1(c) + \Pi_2(c)$ if $\gamma > 0.65$ and if $0.61 \leq \gamma \leq 0.65$, if $c > c^{L''}$, where $c^{L''} = \frac{4-3\gamma^2+\gamma^3-\gamma\sqrt{-4+4\gamma+5\gamma^2-2\gamma^3+\gamma^4}}{4+2\gamma-2\gamma^2}$ and $c^{L'} = \frac{2(-2+\gamma+\gamma^2)^2}{4-3\gamma^2-\gamma^4}$. The statement in the proposition directly follows the previous inequalities. ■

## Proof of Proposition 3.7

We shall proceed to compare welfare under a merger and under the status quo in the two relevant regions.

If $c \leq c^P$, $W^m \geq W^{sq}$ if $\gamma \leq 0.69$ and $c \geq c^{ms'}$, and if $0.69 < \gamma \leq 0.71$ and $c^{ms'} \leq c \leq c^n$, where $c^{ms'} = \frac{4(1-\gamma)(2+\gamma)^2(3-2\gamma)-(4-\gamma^2)\sqrt{8(1-\gamma)(18-18\gamma-19\gamma^2+8\gamma^3+6\gamma^4}}{2(24-18\gamma^2+4\gamma^4)}$ and $c^n = \frac{4(1-\gamma)(2+\gamma)^2(3-2\gamma)+(4-\gamma^2)\sqrt{8(1-\gamma)(18-18\gamma-19\gamma^2+8\gamma^3+6\gamma^4}}{2(24-18\gamma^2+4\gamma^4)}$.

If $c > c^P$, $W^m \geq W^{sq}$ if $\gamma \leq 0.69$, and if $\gamma > 0.69$ and $c \geq c^{ms''}$, where $c^{ms''} = \frac{2-2\gamma^2+\gamma\sqrt{2(-1+\gamma+2\gamma^2)}}{2(1+\gamma)}$ and $W^{sq}$ denotes welfare under the status quo. The statement in the proposition directly follows the previous inequalities. ■

Proof of Proposition 3.8

We have that for $\gamma \leq 0.61$ licensing is always profitable for the patentee and mergers should not be allowed. For $0.61 \leq \gamma \leq 0.65$, we have $c^{L''} > c^{ms'}$,which implies that mergers should be allowed in this region for $c \geq c^{L''}$. For $0.65 \leq \gamma \leq 0.69$, we have $c^{L'} > c^{ms'}$, which implies that mergers should be allowed in this region for $c \geq c^{L'}$. For $0.69 < \gamma < 0.710$, we have $c^{ms'} < c^{L'} < c^{n}$ and $c^{ms''} > c^{n}$, which implies that mergers should be allowed in this region if either $c^{L'} \leq c \leq c^{n}$ or $c \geq c^{ms''}$. For $0.710 < \gamma < 0.7112$, we have that $c^{n} < c^{L'} < c^{ms''}$, which implies that mergers should be allowed in this region for $c \geq c^{ms''}$. Finally, for $\gamma > 0.7112$, $c^{n}$ and $c^{ms'}$ does not exist and $c^{L'} < c^{ms''}$, which implies that mergers should be allowed in this region for $c \geq c^{ms''}$. ■

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