TAKEOVERS AND LICENSING IN SPATIAL COMPETITION[1]

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Abstract

We consider a research laboratory that owns a patented process innovation and considers the possibility to acquire either one or the two symmetric productive firms located at the opposite ends of the Hotelling line. After the takeover decisions, technology transfer takes place inside the newly created firms and through licensing to the remaining independent firms. Each takeover decision is associated with established models of licensing and competition, with no takeover representing the case of an external patentee, one takeover without licensing serving as the status quo, one takeover with licensing representing an internal patentee, and two takeovers corresponding to full monopolization. Our analysis reveals that licensing by an internal patentee results in full monopolization. Consequently, the optimal merger policy prescribes to forbid all takeovers if the antitrust authority aims to maximize consumer surplus. However, if licensing could be prohibited, the optimal structure involves one takeover without licensing. This market structure enables the transfer of technology while avoiding the anticompetitive and collusive effects of the licensing contracts.

Key Words: Licensing, Merger, Two-part tariff, Welfare

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1. Introduction

A firm owning an innovation can transfer it to another firm either externally through a licensing contract or internally through a merger. Facing these two alternatives, the antitrust authority would rather choose licensing. For example, as one can read in Section 10 of the US Horizontal Merger Guidelines (08/19/2010): "The Agencies credit only those efficiencies likely to be accomplished with the proposed merger and 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". And in footnote 13, they further explain "The Agencies will not deem efficiencies to be merger-specific if they could be attained by practical alternatives that mitigate competitive concerns, such as divestiture or licensing" (see the official web of the United States Department of Justice https://www.justice.gov/atr/horizontal-merger-guidelines-08192010). The same rule is applied also to the case of vertical mergers (see the Vertical Merger Guidelines 2020, p.11).

In the present paper, we want to study, on the one hand, whether this preference for licensing over merger is justified according to some welfare standard. We will mainly focus on the effect of different technology transfer schemes on consumer surplus, which is the most common objective enforced by antitrust authorities, although some comments will be devoted as well to the effect on social welfare. On the other hand, we aim to study the private incentives to engage in licensing agreements versus the profits obtained through mergers. In other words, we aim to know which technology transfer scheme is preferred by the owner of an innovation in the case of a laissez-faire antitrust policy.

For this purpose, we consider two duopolistic firms that produce (symmetrically) differentiated goods *a la* Hotelling[5] with the same marginal cost and a laboratory that owns a patented process

[5] Licensing under spatial competition was first introduced by Poddar and Sinha (2004) in the Hotelling linear city model. They consider both the cases of an insider and an outsider patentee. Later, this framework was used by various researchers, addressing different aspects of licensing contracts and their welfare implications (see Kabiraj and Lee (2011), Lu and Poddar (2014), Banerjee and Poddar (2019) among others).

innovation that allows to reduce the cost of the firms by the same amount.

We consider four different scenarios:

(i) (pure merger) The laboratory transfers the technology to one of the firms internally through an acquisition, but it does not license the technology to the other firm.

(ii) (full merger) The laboratory transfers the technology through the acquisition of the two competitors. Therefore, the market is fully monopolized.

(iii) (internal patentee) The laboratory transfers the technology to one of the firms internally through an acquisition and it licenses the technology to the other firm.

(iv) (pure licensing) The laboratory licenses the technology to both firms. This setting is known in the literature as the case of an external patentee.

When licensing the technology, the patentee uses two-part tariff contracts, i.e., a combination of a fixed fee F and a per unit royalty r. 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) firms to exit the industry and would likely be held illegal by antitrust authorities". In the external patentee case (scenario (iv)), the non-negativity of F assumption implies that the royalty cannot exceed the size of the innovation. However, in the internal patentee case (scenario (iii)), royalties larger than the size of the innovation are compatible with positive fixed fees. The reason is that, in this case, the licensing contract not only allows the transfer of the technology but induces a collusive behavior by the patentee: by setting a high price the patentee increases the rival's demand and, subsequently, its licensing revenues. In other words, including a positive royalty in the contract allows the patentee not only to control the marginal cost of the licensee but also to commit itself to a higher price. This "collusive effect" of licensing contracts was first identified in Fauli-Oller and Sandonís (2002).

Nevertheless, so far, all papers studying the case of an internal patentee in a Hotelling setting have assumed that the royalty cannot be larger than the size of the innovation. Their argument to impose this restriction (see, for example, Banerjee, Mukherjee and Poddar (2023), footnote 11) is that if it is not satisfied, the licensee would prefer to use the inefficient technology and, therefore, it would not pay any royalties. But this is a particular interpretation of the licensing contract. An alternative

one is that, when signing the licensing contract, the licensee commits to pay a royalty per unit sold independently of the technology it uses. This is the interpretation we use here, that turns out to be realistic. For example, in the case of the U.S. Federal Trade Commission against Microsoft, on July 15, 1994 the FTC filed a complaint… "the complaint identifies Microsoft's use of *per processor licenses*….as exclusionary and anti-competitive contract terms to maintain its monopoly. A *per processor license* means that Microsoft licenses an operating system to an Original Equipment Manufacturer (OEM), which pays a royalty to Microsoft for each PC sold regardless of whether a Microsoft operating system is included in that PC" (see the official web of the United States Department of Justice https://www.justice.gov/atr/memorandum-opinion-us-v-microsoft-corp).

The first interesting result we obtain is that the internal patentee case and full merger (scenarios (iii) and (ii)) are fully equivalent in the sense that both yield the same market outcomes in terms of consumer surplus, producer surplus and total social welfare. This surprising result that the internal patentee case can be as anticompetitive as a full merger comes basically from the nature of spatial competition which implies an inelastic demand, from our unrestricted royalty assumption and from the existence of the collusive effect of licensing.

It is interesting to emphasize that the equivalence result that we obtain in this work is novel in the patent licensing literature in the sense that, unlike the previous studies, we show the equivalence between *a licensing technology transfer scheme and a non-licensing technology transfer scheme (merger).* So far in the licensing literature, there exist equivalence results between different licensing schemes only. For example, Niu (2013) in a duopoly with symmetric product differentiation shows that ad-valorem profit royalty licensing and per-unit royalty licensing are equivalent for an insider patentee regarding both profitability and welfare. Colombo et. al. (2021) find also an equivalence result between two different licensing schemes for the case of an outsider innovator when firms compete *a la* Cournot. They show that fixed fee licensing and ad-valorem profit royalty licensing are equivalent for any number of licenses the innovator puts up for sale, i.e., these two schemes give the same licensing revenue and welfare. However, this equivalence result does not hold when the patentee is an insider.

Next, we obtain the optimal merger policy in the understanding that the antitrust authority can affect the *structure* of the market by limiting the number of acquisitions that take place, but it cannot affect the *conduct* of firms, namely it cannot forbid licensing. Given the equivalence result, we need to compare pure licensing (scenario (iv)) with full monopolization (scenario (ii)). Social welfare is found to be the same in both scenarios because the market is covered in both cases, consumers patronize the same firm in both cases and goods are produced efficiently. Given this result, the consumer surplus comparison reduces to compare prices in both situations. And this comparison shows that consumer surplus is lower with full monopolization, as it leads to higher prices. Then, if the antitrust authority gives more weight to consumer surplus than to producer surplus in its objective function, the optimal merger policy should forbid any vertical merger.

Additionaly, we discuss which would be the optimal competition policy if the Antitrust Authority had the power to forbid not only mergers but also licensing. Forbidding licensing in the pure licensing case would not affect prices but it would increase production costs, so it would not be an advisable antitrust policy. The question of forbidding licensing in the internal patentee case is more interesting. On the one hand, forbidding licensing reduces social welfare, because it increases both production (the independent firm produces inefficiently) and transportation costs (because market shares become asymmetric). An interesting implication of this is that we do not find welfare reducing licensing in our setting, as it was the case in Fauli-Oller and Sandonís (2002). On the other hand, as licensing promotes collusion and raises prices, we have that forbidding licensing would increase consumer surplus. Therefore, we do find a case of consumer surplus reducing licensing. And indeed, the scenario that maximizes consumer surplus in our setting is found to be precisely pure merger (scenario (i)).

As far as private incentives are concerned, it is quite intuitive that the laboratory prefers the internal patentee case or the full merger case rather than the pure licensing or pure merger cases because, in the former cases, it can implement the monopoly outcome.

The questions addressed in this paper have been analyzed in Fauli-Oller and Sandonís (2002), Fauli-Oller and Sandonís (2003) and Sandonís and Fauli-Oller (2006) in a linear demand model of product differentiation as in Singh and Vives (1984). Fauli-Oller and Sandonís (2002) compare

pure merger and internal patentee (scenarios (i) and (iii)) and conclude that under price competition, licensing reduces welfare if the size of the innovation is sufficiently large (but not drastic). Fauli-Oller and Sandonís (2003) compare an internal patentee and a full merger (scenarios (iii) and (ii)) and conclude that, with two-part tariffs licensing contracts, social welfare is higher in the internal patentee case than under full monopolization. Sandonís and Fauli-Oller (2006) compare pure licensing with an internal patentee (scenarios (iv) and (iii)). The authors find that licensing as an internal patentee (via a vertical merger) is more profitable than licensing as an external patentee only for small innovations. Regarding social welfare, they get that a vertical merger is welfare improving only for large enough innovations. Combining both results they get a clear-cut policy prescription: all profitable vertical mergers should be forbidden.

The paper unfolds as follows. In the next Section, the model of product differentiation and the assumptions on the laboratory and the two firms are introduced. Section 3 studies scenario (i). Scenarios (ii) and (iii) are studied respectively in Sections 4 and 5. Section 6 studies Scenario (iv), importing the results obtained by Banerjee and Poddar (2019). In Section 7, we study the private incentives of the laboratory to take over firms. Section 8 studies the social welfare effects of the different scenarios. A conclusions Section puts the paper to an end.

2. The Linear City Model

Consider a linear city model, *à la* Hotelling, with two firms A and B along the unit interval $[0,1]$ upon which consumers are uniformly distributed. The size of the market is normalized to one. Each consumer purchases exactly one unit of the good either from firm A or B. Firm A is located at 0 and firm B is located at 1 i.e., at the two extreme points of the city. The transport cost per unit of distance is t and it is borne by the consumers. Thus, the two goods are horizontally differentiated from consumers' point of view. Regarding transport costs, apart from its basic interpretation, we can have alternative interpretations. For example, in a world of digital products (e.g., various software or applications), the total transport cost for a consumer, can also be interpreted as the different learning costs of the consumers using a specific product from a firm. Consumers need to invest time to understand the full functionality of the product or simply getting used to a particular product. In that sense, the horizontal product differentiation in the Hotelling's spatial framework

has modern relevance. The reason for using the Hotelling's model of product differentiation (rather than the standard Singh and Vives (1986) type model of product differentiation) is to capture when the demand is inelastic. There are many goods where demand is perfectly inelastic, that is, consumers only buy one unit of the good. For example, a mobile phone, a computer, other similar electronic gadgets or a car etc.

The utility function of a consumer located at x in the linear city is given by:

$$U = v - p_A - tx \qquad \text{if buys from firm A,}$$

$$= v - p_B - (1 - x)t \quad \text{if buys from firm B,}$$

where v is the basic valuation of the product which is the same for all the consumers. Firms compete in prices; p_A and p_B denote the prices charged by firm A and B respectively. We assume that the market is fully covered.

The demand functions for firm A and firm B can be calculated as:

$$Q_A = \frac{1}{2} + \frac{p_B - p_A}{2t} \qquad \text{if} \quad p_B - p_A \in (-t, t),$$

$$= 0 \qquad \text{if} \quad p_B - p_A \leq -t,$$

$$= 1 \qquad \text{if} \quad p_B - p_A \geq t,$$

and $Q_B = 1 - Q_A$.

Firms have the same marginal cost c_B. There exists a research laboratory that owns a patented cost-reducing innovation that allows to reduce the marginal cost of producing the good to c_A, with $c_A < c_B$. Firm A, firm B and the laboratory play the following three stage game[6]:

1a) The laboratory makes offers to buy firm A and firm B.

1b) Firm A and B either accept or reject the offers.

2a) The laboratory offers two-part tariff licensing contracts to independent firms (if any).

2b) The independent firms (if any) decide whether to accept the licensing contracts.

[6] Throughout the analysis, we implicitly assume a strong IPR regime with no knowledge spillover or copyright violations. In other words, firms can only get the know-how of the superior technology if it is transferred successfully.

3) Firms choose prices to maximize profits.

In the following four Sections we solve the second and third stages of this game, given the market structure determined in the first stage, and delay the resolution of the first stage until Section 7. Each Section has interest on its own sake because they correspond to classical models of licensing and competition:

(i) (pure merger) The laboratory transfers the technology to one of the firms internally through an acquisition, but it does not license the technology to the other firm. This situation is usually known as the status quo.

(ii) (full merger) The laboratory transfers the technology through the acquisition of the two competitors. Therefore, the market is fully monopolized.

(iii) (internal patentee) The laboratory transfers the technology to one of the firms internally through an acquisition and it licenses the technology to the other firm.

(iv) (pure licensing) The laboratory licenses the technology to both firms. This setting is known in the literature as the case of an external patentee.

In the next page, Figure 1 summarizes the game we are going to study, emphasizing how the four cases stated above are obtained because of the takeover and licensing decisions of the laboratory.

3. Pure merger

The laboratory has acquired firm A and compete with firm B in the market with their respective marginal production costs c_A and c_B. They respectively maximize:

$$\max_{p_A}(p_A - c_A)\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right)$$

$$\max_{p_B}(p_B - c_B)\left(\frac{1}{2} + \frac{p_A - p_B}{2t}\right)$$

The maximization programs, lead to the following equilibrium prices, demands and profits:

$$p_A^{PM} = \frac{1}{3}(3t + 2c_A + c_B), \quad (1)$$

$$p_B^{PM} = \frac{1}{3}(3t + c_A + 2c_B), \quad (2)$$

$$Q_A^{PM} = \frac{1}{6t}(3t - c_A + c_B), \quad (3)$$

$$Q_B^{PM} = \frac{1}{6t}(3t + c_A - c_B), \quad (4)$$

$$\pi_A^{PM} = \frac{1}{18t}(3t - c_A + c_B)^2, \quad (5)$$

$$\pi_B^{PM} = \frac{1}{18t}(3t + c_A - c_B)^2. \quad (6)$$

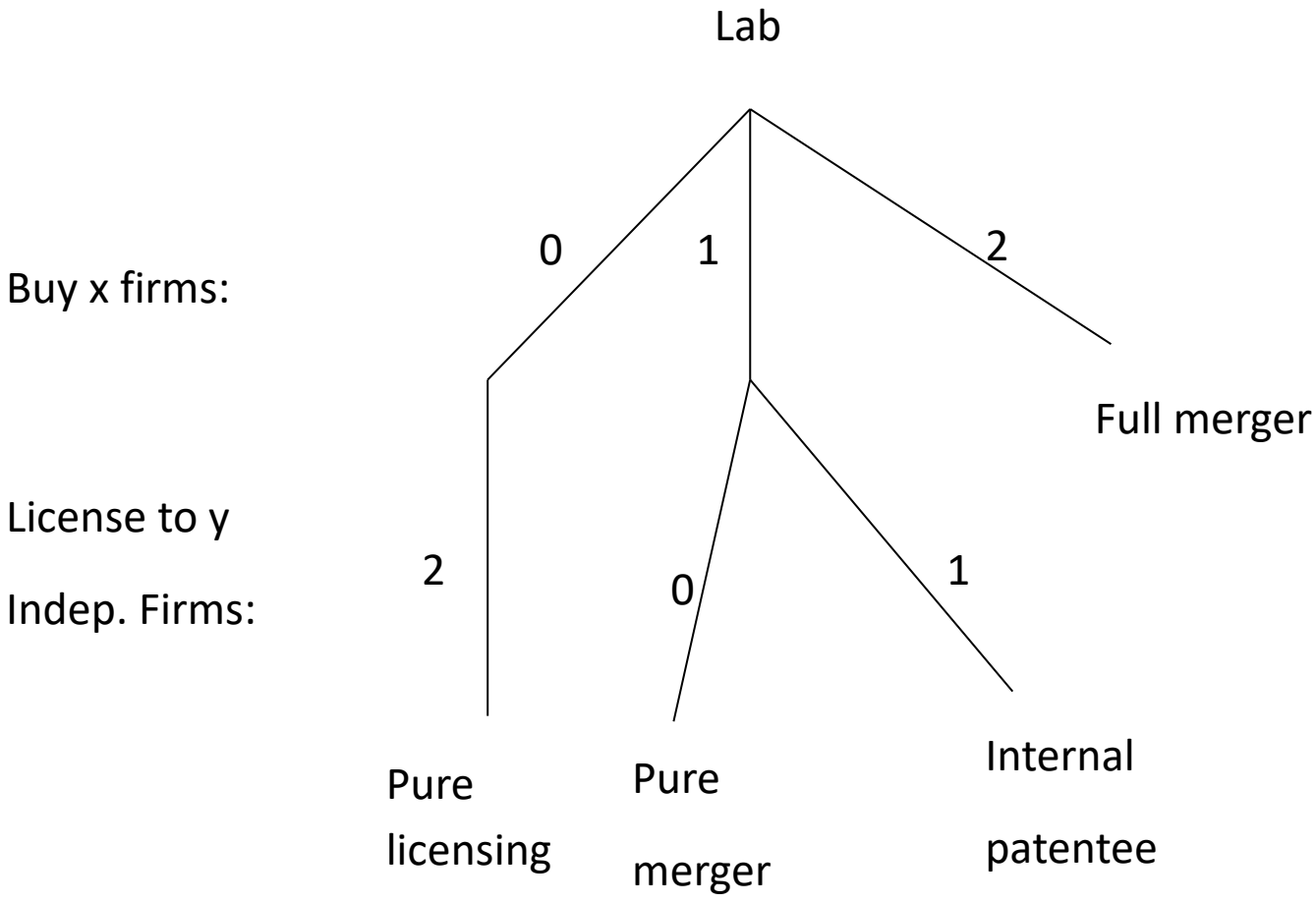

Figure 1: Summary of the game.

We assume:

$$c_B - c_A < 3t, \tag{A1}$$

$$v > \frac{1}{2}(3t + c_A + c_B). \tag{A2}$$

Condition (A1) guarantees that the equilibrium quantities are positive for both firms. Condition (A2), that the market is covered.

The total industry profit amounts to $\pi^{PM} = \frac{1}{18t}(3t - c_A + c_B)^2 + \frac{1}{18t}(3t + c_A - c_B)^2$, which is an increasing function of c_B for all $c_B > c_A$, and attains a minimum at $c_B = c_A$. The minimum value of $\pi^{PM} = t$.

4. Full merger

Let us consider now that the laboratory has bought Firm A and Firm B to form a monopoly. Technology transfer takes place inside the newly created firm, so that the plants previously owned by Firms A and B produce at cost c_A. Next, we study the optimal price (the same in both locations) set by the monopolist.

Suppose that the monopolist wants to sell the good to all consumers at a distance $x \leq \frac{1}{2}$ from each endpoint of the segment. Then, the monopolist will set a price such that the consumers in *x* and *1-x* get a zero surplus: $v - p - tx = 0$, which implies $x = \frac{(v-p)}{t}$. Then, the profits of the monopolist are $\frac{(p-c_A)2(v-p)}{t}$, which are maximized at $p = \frac{(v+c_A)}{2}$. This implies that the monopolist would sell in each end point of the segment $x = \frac{v-c_A}{2t}$. However,

$$\frac{v - c_A}{2t} - \frac{1}{2} > \frac{\frac{3t+c_A+c_B}{2} - c_A}{2t} - \frac{1}{2} = \frac{t + c_B - c_A}{4t} > 0.$$

The first inequality holds because of (A2) and the last inequality because $c_B > c_A$. This means that the monopolist will serve all consumers and that $x = \frac{1}{2}$, and this implies, following the calculations given above, that the monopolist will set a price $p^{FM} = v - \frac{t}{2}$ and obtains profits $\pi^{FM} = v - c_A - \frac{t}{2}$.

5. The internal patentee

Now, suppose that the laboratory has bought firm A (for simplicity let us call the merged entity firm A) and licenses its technology to firm B by means of a two-part tariff contract, i.e., a combination of a fixed fee F and a per unit royalty r. 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) firms to exit the industry and would likely be held illegal by antitrust authorities". Notice that a royalty which is higher than the size of the innovation does not necessarily imply that the fixed fee should be negative for the contract to be acceptable by the licensee. This can be explained by the existence of the collusive effect of the royalty that we discussed in the Introduction. Let us look at the region in which the licensing contract is such that all the consumers buy the product in equilibrium (interior solution).

In the market competition stage, firm A chooses p_A to maximize its market profits plus royalty revenues:

$$\underset{p_A}{Max}\left[(p_A - c_A)\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right) + r\left(\frac{1}{2} + \frac{p_A - p_B}{2t}\right) + F\right],$$

while firm B chooses p_B to maximize its own profits:

$$\underset{p_B}{Max}\left[(p_B - c_A - r)\left(\frac{1}{2} + \frac{p_A - p_B}{2t}\right) - F\right].$$

Maximization by each firm leads to the following equilibrium prices and profits:

$$p_A^{IP} = p_B^{IP} = c_A + t + r,$$

$$\pi_A^{IP} = r + \frac{t}{2} + F,$$

$$\pi_B^{IP} = \frac{t}{2} - F.$$

To understand the equilibrium results, observe that (see Banerjee, Mukherjee and Poddar, 2023) the payoff of firm A can be rewritten as:

$$(p_A - c_A)\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right) + \frac{r}{2} - \frac{r}{2} + r\left(\frac{1}{2} - \frac{p_B - p_A}{2t}\right) + F,$$

$$(p_A - c_A)\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right) - r\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right) + r + F,$$

$$(p_A - c_A - r)\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right) + r + F.$$

Given that r and F at this stage are given, we have the typical symmetric Hotelling model where firms have marginal cost c_A + r. From that model, we know, that prices are symmetric and equal to the marginal cost plus the differentiation parameter t.

This equilibrium result is like the one in Banerjee, Mukherjee and Poddar (2023). Our results below differ from theirs because, contrary to us, they impose that the royalty cannot exceed the size of the innovation ($c_B - c_A$). As we have explained in the Introduction, however, it can be realistic also to allow for an unrestricted royalty, as we do in the present paper.

Firm A will set the fixed fee to extract all the rents from firm B:

$$F_{IP}^* = \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 = \frac{(c_B - c_A)(-(c_B - c_A) + 6t)}{18t} > 0.$$

The sign follows from (A1). As this fee does not depend on r, firm A is interested in setting the largest feasible r. It is the one that extracts all the surplus from the indifferent consumer (consumer in the middle of the line):

$$r_{IP}^* = v - c_A - \frac{3t}{2} > 0.$$

Notice that assumption (A2) guarantees that r_{IP}^* is positive. On the other hand, it can be seen that, for $\frac{1}{2}(3t + c_A + c_B) < v < \frac{3t}{2} + c_B$, we have $r_{IP}^* < c_B - c_A$ and, for larger values of v, $r_{IP}^* > c_B - c_A$.[7]

Given r_{IP}^*, we have that equilibrium prices are given by $p_A^{IP}(r_{IP}^*) = p_B^{IP}(r_{IP}^*) = v - \frac{t}{2}$, which coincide with the monopoly prices derived in the previous Section. Given the above derived optimal values for F and r, the equilibrium profits obtained by firm A through licensing amount to $\pi_A^{IP}(r_{IP}^*, F_{IP}^*) = v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2$. As Firm B obtains its outside option $\pi_B^{IP}(r_{IP}^*, F_{IP}^*) = \frac{1}{18t}(3t + c_A - c_B)^2$, total industry profits amount to $\pi^{IP}(r_{IP}^*, F_{IP}^*) = v - c_A - \frac{t}{2}$, which are exactly the same profits that the laboratory obtains under a full merger and implies that, in our setting, the use of a two-part tariff licensing contract allows the licensor to implement the monopoly outcome.

[7] We discuss how the results change under the assumption $r \leq c_B - c_A$ in the conclusions Section.

We must check whether licensing is profitable i.e., if the profits that firm A gets under the optimal two-part tariff licensing contract are higher than the ones it would obtain without licensing (calculated in Section 3). Formally, licensing is profitable if expression $v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 - \frac{1}{18t}(3t + c_B - c_A)^2$ is positive.

It is direct to see that, given (A2), the previous expression is greater than $\left(\frac{1}{2}(3t + c_A + c_B)\right) - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 - \frac{1}{18t}(3t + c_B - c_A)^2 = \frac{(c_B - c_A)(9t - 2(c_B - c_A))}{18t}$.

But given (A1), the previous expression is positive i.e., licensing the technology is profitable.

The last thing that remains to be discussed is whether the licensor could have an incentive to increase the royalty above the optimal (interior) royalty obtained above, so that not all consumers buy the good, in other words, such the market is uncovered. But it is very intuitive that this strategy cannot be optimal because, as we have just seen, the profits that firm A gets under two-part tariff licensing with the interior solution are exactly the monopoly profits minus the outside option of firm B, which implies that firm A could not get higher profits by increasing the royalty above the optimal (interior) one.

We formalize the above discussion in the following proposition:

Proposition 1

In a spatial framework with product differentiation and an internal patentee, the optimal two-part tariff licensing contract includes a positive royalty $r_{IP}^* = v - c_A - \frac{3t}{2}$ *and a positive fixed fee* $F_{IP}^* = \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2$. *Furthermore, equilibrium prices are* $p_A^{IP}(r_{IP}^*) = p_B^{IP}(r_{IP}^*) = v - \frac{t}{2}$, *and total industry profits equal to* $\pi^{IP}(r_{IP}^*, F_{IP}^*) = v - c_A - \frac{t}{2}$.

Now, given that under two-part tariff licensing we have the same profits and the same prices that we would have under a merger, we can conclude that a merger to monopoly and two-part tariff licensing are equivalent in all respects. We formalize this result in the following proposition:

Proposition 2

Two-part tariff licensing in a duopoly and a merger to monopoly lead to the same Social Welfare,

Producer Surplus and Consumer Surplus.

The surprising result that in our setting two-part tariff licensing by an internal patentee can be as anticompetitive as a full merger comes basically from the nature of spatial competition which implies an inelastic demand (that allows the patentee to set high royalties, which lead to high prices, without being concerned by a reduction in sales), from our unrestricted royalty assumption and from the collusive effect of licensing when firms compete in prices in this scenario. Contrary to what the 2010 US Horizontal Merger Guidelines prescribes, we obtain that, as a transfer technology scheme, licensing is not necessarily welfare superior to a merger.

6. Pure licensing

If no merger has occurred in the first stage, the laboratory licenses the technology, as an external patentee, to the two independent firms. As usual, we assume also that the market is covered in equilibrium, which in this setting it is guaranteed by condition:

$$v > c_B + \frac{3t}{2}. \qquad \text{(A3)}$$

The result for the case in which the laboratory licenses the innovation as an external patentee can be found in Banerjee and Poddar (2019) p. 299. They obtain that the laboratory finds optimal to license to both firms with a licensing contract that includes a positive royalty equal to the size of the innovation, namely, $r_{PL}^* = c_B - c_A$ and a zero fixed fee $F_{PL}^* = 0$.[8] Notice that being an external patentee prevents the laboratory from setting a royalty higher than the size of the innovation, as this would imply that in order for the participation constraint of the licensees to hold, the fixed fee should become negative, which we do not allow in the present paper. The optimal contract leads to profits $\pi_{LAB}^{PL}(r_{PL}^*, F_{PL}^*) = c_B - c_A$ for the patentee (notice that (A3) guarantees that the market is covered in equilibrium and, as a consequence, that total demand equals 1) and each licensee gets profits $\pi_A^{PL}(r_{PL}^*, F_{PL}^*) = \pi_B^{PL}(r_{PL}^*, F_{PL}^*) = \frac{t}{2}$ (which are the typical Hotelling profits for the symmetric case).

[8] Banerjee and Poddar (2019) consider indeed a more general setting in which the two licensees may have different marginal costs.

7. The acquisition stage (first stage)

The laboratory has three options: buying no firm, buying one firm or buying two firms. If it buys no firm, it will license the technology to both firms as an external patentee obtaining a payoff (see Section 6):

$$\pi_{LAB}^{PL} = c_B - c_A \qquad (7)$$

Next, we describe the case in which the laboratory acquires one of the firms in the industry and licenses the innovation to the rival firm as an internal patentee.[9] This case has been analyzed in Section 5. We assume that the external laboratory offers to the two firms an acquisition price to buy one and only one firm. The optimal acquisition price is the one that leaves any of the firms indifferent on whether to accept or reject the offer, namely, the profits it would obtain being licensed by an internal patentee (its outside option, namely $\frac{1}{18t}(3t + c_A - c_B)^2$). Recall that from Section 5, we know that the profits of the internal patentee are $\pi_A^{IP}(r_{IP}^*, F_{IP}^*) = v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2$. Therefore, to obtain its net profits, we have just to subtract from the previous expression the acquisition price ($\frac{1}{18t}(3t + c_A - c_B)^2$) to get:

$$v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 - \frac{1}{18t}(3t + c_A - c_B)^2 \qquad (8)$$

If the laboratory acquires the two firms, it monopolizes the market and obtains (gross of the acquisition price) a payoff equal to $\pi^{FM} = v - c_A - \frac{t}{2}$ (see Section 4). The acquisition price, in this case, is the profit that any firm would get if it rejected the acquisition offer when the rival firm accepts it (its outside option). In other words, the profits it gets when it licenses the innovation from an internal patentee, which amounts to $\frac{1}{18t}(3t + c_A - c_B)^2$. So, the net payoff of acquiring the two firms is:

$$v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 - \frac{1}{18t}(3t + c_A - c_B)^2. \qquad (9)$$

The optimal takeover policy of the laboratory is obtained by comparing expressions (7), (8) and

[9] In Section 5, we checked that licensing is profitable in this case.

(9).

We next check that (8) is higher than (7):

$$\left[v - c_A - \frac{t}{2} - \frac{1}{18t}(3t + c_A - c_B)^2 - \frac{t}{2}\right] - [c_B - c_A] = v - c_B - t - \frac{1}{18t}(3t + c_A - c_B)^2 \geq$$

$$v - c_B - \frac{3t}{2} > 0.$$

The first inequality comes from the fact that $\frac{1}{18t}(3t + c_A - c_B)^2$ reaches it maximum value when c_A=c_B. The second one is implied by condition (A3).

We see that expressions (8) and (9) coincide. We can then conclude that the optimal takeover decision by the laboratory is buying either one or the two firms. Next Proposition summarizes this result:

Proposition 3: The laboratory optimally acquires either one or the two firms.

8. Welfare considerations

Next, we obtain the optimal merger policy in the understanding that the antitrust authority can affect the *structure* of the market by limiting the number of acquisitions that take place, but it cannot affect the *conduct* of firms, namely it cannot forbid licensing. Given the equivalence result (see Proposition 2), we need to compare pure licensing with the internal patentee case. In other words, to compare the scenario with an external patentee and the one with an internal patentee.

Concerning the welfare comparison between these two settings, it is very intuitive to see that social welfare is unaffected: given that the market is covered in both cases, we need to compare only the costs incurred in each situation. As far as transportation costs are concerned, they do not change, given that consumers patronize the same firm in both situations. As far as production costs are concerned, they do not change either, because both firms produce with the new technology in both cases.

More interesting is to look at the effect on consumer surplus. Given that consumers patronize the same firm in both settings, the analysis reduces to compare the equilibrium prices under an internal

and an external patentee, namely, $\left[v-\frac{t}{2}\right]-[c_B+t]=v-c_B-\frac{3t}{2}>0$. The inequality is implied by (A3). Notice that the first bracket is the monopoly price, and the second bracket corresponds to the Hotelling price when firms have symmetric costs equal to r*+c_A which amounts to c_B+t.
The previous analysis is summarized in the following Proposition.

Proposition 4: The optimal merger policy calls for forbidding all mergers if the Antitrust Authority gives more weight to consumer surplus than to producer surplus in its objective function.

The last point we want to address is the optimal antitrust policy if the antitrust authority had the power to forbid licensing and maximizes consumer surplus. We have checked that consumer surplus is higher with pure licensing than with the internal patentee case or full merger. Forbidding licensing in the pure licensing case would not affect prices but it would increase production costs, so that it is not an advisable antitrust policy. The only comparison which is left is between pure licensing and pure merger.
The difference between consumer surplus under pure merger and consumer surplus under pure licensing is given by:

$$\int_0^{Q_A^{PM}}(v-p_A^{PM}-tx)dx+\int_{Q_A^{PM}}^{1}\left(v-p_B^{PM}-t(1-x)\right)dx$$
$$-2\int_0^{1/2}(v-(c_B+t)-tx)dx=\frac{(c_B-c_A)(18t+c_B-c_A)}{36t}>0.$$

The first two terms correspond to consumer surplus under pure merger and the third one to consumer surplus under pure licensing. Notation p_A^{PM} and p_B^{PM} refer to the equilibrium prices under pure merger and Q_A^{PM} refers to the equilibrium market share of firm A in this case. Then, consumer surplus is maximized under pure merger, because this scenario facilitates that the superior technology is transferred but prevents the anticompetitive effect of licensing contracts to occur.

Up to now, we have not considered the case where the external laboratory licenses to only one firm, because, without any restriction, it prefers to license to both firms (See the Appendix, part A). However, if it was the case that the Antitrust Autrority can forbid not only mergers but also licensing, we should contemplate this possibility to check how it performs as far as consumer

surplus is concerned. In the Appendix, Part B, we show that consumer surplus is higher under the pure merger case than under the case where the technology is licensed to only one firm. Therefore, even allowing the Antitrust Authority to forbid the laboratory to license to more than one firm, does not alter the fact that pure merger is the market structure that maximizes consumer surplus. And the only way for the the Antitrust Authority to induce the pure merger case to arise in equilibrium is to allow only one merger and forbid licensing. Observe that the profits of the merged entity under pure merger are higher than the ones any of the (symmetric) firms would obtain without technology transfer.

$$\frac{1}{18t}(3t - c_A + c_B)^2 - \frac{t}{2} > 0.$$

9. Concluding remarks

It is instructive to distinguish between the anticompetitive and the collusive effects of licensing contracts. The first is to be found in the case of an external patentee, because the royalty is set equal to the size of the innovation, so that the effective cost of the licensees does not change under licensing. The second effect is found in the case of an internal patentee. In this case, at the pricing stage, the patentee maximizes the sum of market profits plus royalty revenues. The latter are increasing in the price set by the patentee because a higher price increases the licensee's sales and the royalty revenues. So the licensing contract induces the patentee to set higher prices. And given that prices are strategic complements, the licensee optimally responds by increasing its price too. And this collusive effect is so important that it leads to full monopolization. These effects have been obtained previously in the literature (see, for example, Fauli-Oller and Sandonís, 2002), but they are exacerbated here, because the assumption that the market is covered implies that demand is inelastic. This allows the patentee to set high royalties, that induce high prices, without fearing a reduction in the sales to consumers.

The main message of the paper is that licensing contracts not only serve to transfer a given technology, but they can also distort competition in a way prejudicial to consumers. This latter effect calls for policy intervention. In this sense, initiatives that regulate the terms of the licensing contracts like the FRAND (fair, reasonable and non-discriminatory) agreements are very welcome.

It is interesting to discuss how our results would change if we impose the assumption mostly used in the literature that $r \leq c_B - c_A$ in the case of an internal patentee. In this situation, when v is low enough, the unrestricted royalty r^*satisfies this constraint and our results would not change. When v is larger, however, the constraint is binding and $r^* = c_B - c_A$, which implies that equilibrium prices would be lower and, therefore, we would have that consumer surplus under two-part tariff licensing would be higher that under a merger to monopoly.

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APPENDIX

PART A

We study the optimal licensing contract if the laboratory can only license its technology to one firm (e.g., firm A). We assume that if firm A rejects the contract no licensing takes place. The equilibrium results of the pricing stage are like the ones of the pure merger case replacing c_A by $c_A + r$. To design the optimal two-part tariff licensing contract, the laboratory maximizes licensing revenues subject to the participation constraint of firm A and the non-negativity of the fixed fee:

$$\underset{r,F}{Max}\ \frac{r}{6t}(3t - c_A - r + c_B) + F$$

$$s.t. F \geq 0, \frac{1}{18t}(3t - c_A - r + c_B)^2 - F \geq \frac{t}{2}$$

We can replace F in the objective function by the value that binds the second restriction. The first restriction can be replaced by $r \leq c_B - c_A$, so that the maximization program only depends on r:

$$\max_r \pi(r) = \frac{r}{6t}(3t - c_A - r + c_B) + \frac{1}{18t}(3t - c_A - r + c_B)^2 - \frac{t}{2}$$

$$s.t. r \leq c_B - c_A$$

The optimal royalty r* is given by:

$$\frac{1}{4}(c_B - c_A + 3t)\ if\ \frac{c_B - c_A}{3} < t < c_B - c_A\ and\ c_B - c_A\ otherwise$$

We want to check that the laboratory obtains more profits licensing to both firms ($c_B - c_A$) that licensing to only one firm. This is the case if $t \geq c_B - c_A$, because licensing to only one firm the laboratory obtains $\frac{c_B - c_A}{2}$. To prove it for

$\frac{c_B-c_A}{3} < t < c_B - c_A$, we have to see that the following expression is negative: $P(t) = \pi(r^*) - (c_B - c_A) = \left(\frac{1}{16t}\right)((c_A - c_B)^2 + 10(-c_A + c_B)t + t^2)$.

We have that: $P^{'}(t) = \left(\frac{1}{16}\right)\left(1 - \frac{(c_A-c_B)^2}{t^2}\right) < 0$. The sign follows from $t < c_B - c_A$.

As $P\left(\frac{c_B-c_A}{3}\right) = \frac{5(c_A-c_B)}{12} < 0$, $P(t) < 0$ for all $\frac{c_B-c_A}{3} < t < c_B - c_A$ as we wanted to prove.

PART B

The difference between consumer surplus under pure merger and consumer surplus under licensing to only one firm if $\frac{c_B-c_A}{3} < t < c_B - c_A$ is given by:

$$\int_0^{Q_A^{PM}} (v - p_A^{PM} - tx)dx + \int_{Q_A^{PM}}^1 \left(v - p_B^{PM} - t(1-x)\right)dx$$
$$- \int_0^{Q_A^L} (v - p_A^L - tx)dx - \int_{Q_A^L}^1 \left(v - p_B^L - t(1-x)\right)dx$$
$$= \frac{(7c_A - 7c_B - 69t)(c_A - c_B - 3t)}{576t} > 0$$

where $p_A^L = \frac{1}{3}(3t + 2c_A + 2r^* + c_B)$,

$p_B^L = \frac{1}{3}(3t + c_A + r^* + 2c_B)$,

$Q_A^L = \frac{1}{6t}(3t - c_A - r^* + c_B)$,

When $t \geq c_B - c_A$, the consumer surplus with only one licensee is the same as the one with pure licensing, because in both cases we have that both firms have cost c_B. In the main text we have checked that the consumer surplus in this case was higher with pure merger. Therefore, even allowing the Antitrust Authority to forbid the laboratory to license to more than one firm, does not alter the fact that pure merger is the market structure that maximizes consumer surplus.