

INNOVATION, MERGER POLICY AND TECHNOLOGY TRANSFER

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We consider the interactions between innovation and merger policy under different assumptions on technology transfer. In the absence of licencing, we show that in some cases the government must commit to a permissive policy to ensure that socially desirable innovations take place, while in other cases it must commit to a prohibitive policy to deter socially wasteful innovation investments. We also find that in some circumstances the absence of any commitment is socially necessary to ensure that innovation takes place, although mergers are finally allowed. In contrast with recent literature on licencing, we show that a permissive merger policy can be optimal even if royalties and fees are available in licencing.

Keywords: Merger policy, innovation, licencing.

(JEL L13, L4, O32)

1. Introduction

In this paper we consider the interactions between merger policy and innovation, taking into account different scenarios for technology transfer. The aim of our contribution is twofold. First, we analyze the social desirability of long run commitments regarding merger policy, taking into account the strategic interactions between the antitrust authority and the firms. Second, we investigate the implications of endogenous innovation on the optimal merger policy, when licencing contracts are an alternative to merger as a technology transfer device.

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In the literature about the welfare effects of mergers, it is usually assumed that there is a trade-off between the cost-savings associated with mergers and the lower competition arising from it. This trade-off, which is a basic ingredient in the US Merger Guidelines, has been analyzed by Williamson (1968) and by McAfee and Williams (1992) among others. In those contributions, it is assumed that the available technology is exogenous. Thus, if the government maximizes social welfare the optimal merger policy implies that the merger should be allowed if and only if post merger welfare is greater than the pre-merger welfare, given the technology.

However, we show that this simple rule is not always optimal in the context of endogenous technological choice. On the one hand, the antitrust authority should take into account the effects of its merger policy on the incentives to innovate. On the other hand, it should also consider the firms' ability to influence its decision. As it has been pointed out by Röller *et al.* (2001) there is a small amount of economic literature dealing with the effects of mergers in industries where advertising and R&D are important, despite the fact that those industries are the most concentrated (which implies that mergers in those industries are more likely to have important anticompetitive effects). As a result of this state of the art, the report about the *efficiency defence of mergers* by the European Commission (2001) has focused mainly on the cases of exogenous scale economies, with little attention to the endogenous scale economies associated with R&D. This has also been reflected in the recently published EU Horizontal Merger Guidelines¹. Nevertheless, some recent literature has focused on the endogenous character of the technology in the context of mergers. In particular, Banal-Estañol *et al.* (2004) have analyzed the interactions between mergers and the incentives to invest in R&D. Those authors conclude that a regulator should be careful in assuming that the potential efficiency gains associated with merger will be realized, which affects the optimal merger policy. In a similar line, Faulí-Oller and Pastor-Gosálbez (2002) have analyzed the effects of merger policy on the incentives to innovate. In essence, these previous contributions recognize the influence of merger policy on the incentives to innovate but they do not consider the influence of the firms' R&D investment on merger policy. In contrast, we study the interactions between both

¹See European Commission (2004).

types of decisions in the context of a multistage game where different possibilities of policy precommitments are analyzed.

In particular, we consider a model with only two initial firms where the government can choose among three options: first, a commitment to a permissive policy about mergers (i.e., to allow the merger); second, a commitment to a prohibitive policy (i.e., not to allow the merger) and, third, a contingent policy (i.e., to postpone the decision about the merger until the technology is chosen). In this context, we show that in some cases a commitment to a *laissez-faire* policy is optimal. In other words, the government might find it socially profitable to commit to allowing the merger before the technology is chosen, in order to ensure that the socially efficient technology is finally chosen. In contrast, there are cases where a commitment to prohibit the merger is necessary to deter socially inefficient innovations. On the other hand, we also identify the cases where the lack of commitment is necessary to stimulate socially desirable innovations. In fact, we show that, in these cases the government can use the credible threat of challenging the merger to ensure that the socially efficient technology is chosen, although the merger is finally allowed.

The basic intuition of these results relies on something which is absent in many discussions about merger policy: the potential efficiency gains of mergers are usually associated with substantial investments prior to the merger. In consequence, the antitrust authority should take into account not only the magnitude of such investments, but also the convenience of a previous precommitment to either a prohibitive policy (if the potential investment is wasteful) or a permissive policy (if the potential investment is socially profitable). Therefore, our results emphasize the intertemporal consistency problems associated to merger policy. In some cases it is a crucial element the regulator's ability to commit, for instance, to a permissive policy even if after the innovation the regulator would like to reverse its decision. In the following section we will discuss this issue further.

We will also consider the case where licensing is available. In this context, our results contrast with recent literature about the optimal merger policy. In particular, Faulí-Oller and Sandonís (2003) have shown that, from the social welfare point of view, licensing contracts dominate mergers as a technology transfer device if both royalties and fees are available, *assuming that the superior technology is exogenously given*. We will show that this conclusion is not robust to explicitly

considering the endogenous nature of innovation. In our model we identify the cases where even with this type of licensing contract, a long run commitment to allow mergers is optimal for the antitrust authority, in order to stimulate innovation. In those cases such commitment is made under the condition that the innovation takes place.

The rest of the paper is as follows: in Section 2 we analyze the basic model without licensing, in Section 3 we extend the model to allow for licensing and Section 4 gathers our conclusions. The formal proofs are in the appendix.

2. The basic model

There are two initial firms (denoted by 1 and 2) in the market for a homogenous good. Without loss of generality, firm 1 has the possibility of choosing between the current technology (the old technology in the subsequent analysis) or a new technology that involves some innovation cost, which can be interpreted as R&D investment. For simplicity, we assume that firm 2 can not innovate. Once the technology (new or old) has been chosen, then firm 1 can make a merger proposal by means of a takeover offer. More precisely, if merger is allowed, then firm 1 compensates firm 2 exactly by its reservation pay-off, that is, its profits in the case of duopoly competition between both firms. Stenbacka (1991) and Wong and Tse (1997) consider a similar approach in a model where they analyze the interdependence between innovation and takeovers but with no role for the merger policy.

The interactions between firms and government are given by the following multi-stage game:

STAGE 1: The government decides to choose its merger policy either before firm 1's technological decision (denoted by B) or after such a decision (denoted by A). If the government decides B then it chooses either to allow merger (which yields a monopoly denoted by M) or not to allow merger (which yields a duopoly denoted by D). In the following analysis we will denote by BD and BM the government's choice of B followed, respectively, by D and M .

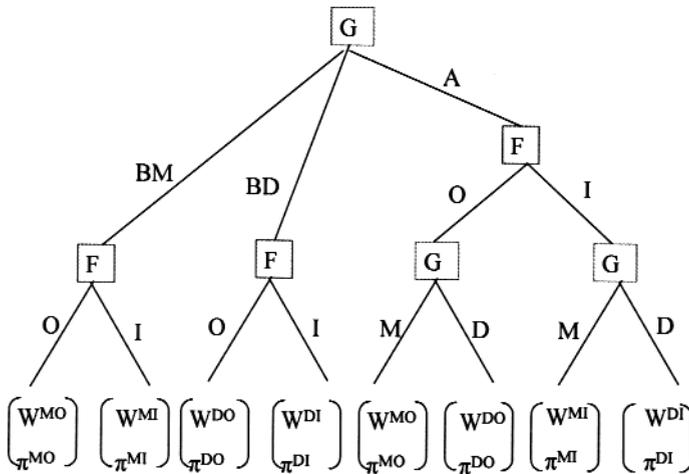
STAGE 2: Firm 1 decides either to innovate (denoted by I) or to choose the old technology (denoted by O).

STAGE 3: If the government has chosen A at stage 1, then it chooses either to allow the merger (which yields a monopoly denoted by M) or not to allow it (which yields a duopoly denoted by D).

STAGE 4: Cournot competition among active firms takes place.

The structure of the previous game is represented in figure 1, where G denotes government and F denotes firm 1.

FIGURE 1
The basic game



The following assumptions will be maintained throughout the paper, relative to technology and preferences:

ASSUMPTION 1: The cost function of firm i is given by $C(x_i) = cx_i$ with the old technology, and by $C_i(x_i) = K$, with the new technology, where $c > 0$, x_i is the production of firm i and K is the investment cost, associated with innovation.

ASSUMPTION 2: Consumers are perfectly competitive and maximize their consumer surplus, given by $CS \equiv u(x) - px$, where x is total consumption of the homogeneous good, p is the price, and $u(x) = x - \frac{x^2}{2}$.

Note that assumption 2 is equivalent to assuming a linear inverse demand function $p = 1 - x$.

ASSUMPTION 3: The government's objective is to maximize total welfare, given by $W \equiv CS + \Pi$, where Π are total profits in the industry. This can be rewritten as $W = x - \frac{x^2}{2} - C_1(x_1) - C_2(x_2)$.

We will also assume that $c < 1/2$, which ensures that in a duopoly firm 2's output will always be positive.

2.1 The results

First, consider the Nash Equilibrium at stage 4 of the game. We have the following cases:

i) Duopoly with both firms using the old technology (denoted by DO). Standard computations show that the Nash equilibrium payoffs for each firm (denoted by π) and the government are, respectively

$$\pi^{DO} = \frac{(1-c)^2}{9} \text{ and } W^{DO} = \frac{4}{9}(1-c)^2. \quad [1]$$

ii) Duopoly with innovation (denoted by DI). The payoffs of firm 1, firm 2 and the government are, respectively

$$\pi^{DI} = \frac{(1+c)^2}{9} - K; \pi_2^{DI} = \frac{(1-2c)^2}{9} \text{ and } W^{DI} = \frac{(8-8c+11c^2)}{18} - K. \quad [2]$$

iii) Monopoly with old technology (denoted by MO). In this case, total monopoly profits will be given by $\Pi^{MO} = (1-c)^2/4$, and the payoffs of firm 1 and government will be given, respectively, by

$$\pi^{MO} = \Pi^{MO} - \pi^{DO} = \frac{5(1-c)^2}{36} \text{ and } W^{MO} = \frac{3(1-c)^2}{8}. \quad [3]$$

iv) Monopoly with innovation (denoted by MI). In this case, total monopoly profits will be given by $\Pi^{MI} = 1/4 - K$, and the payoffs of firm 1 and government will be given, respectively, by

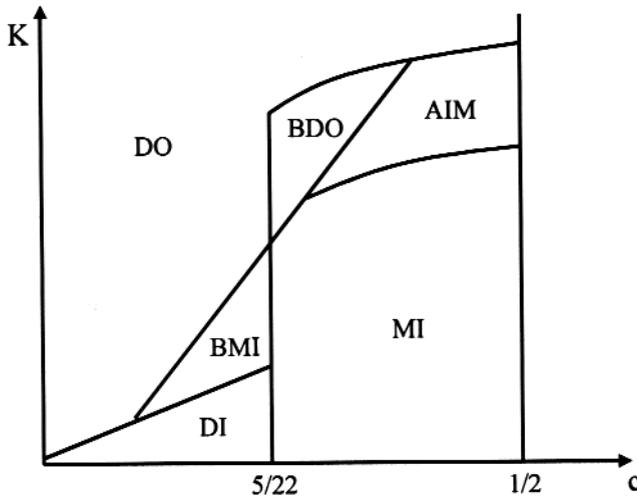
$$\pi^{MI} = \Pi^{MI} - \pi_2^{DI} = \frac{(5+16c-16c^2)}{36} - K \text{ and } W^{MI} = \frac{3}{8} - K. \quad [4]$$

The subgame perfect equilibrium (SPE) of the game assumed in this section is characterized by the following proposition and illustrated in figure 2.

PROPOSITION 1 *Under assumptions 1, 2 and 3, the SPE of the game presented in this section satisfies the following properties:*

- i) For intermediate-low levels of K and intermediate-low levels of c (region BMI) the innovation is made and the merger is allowed. The government chooses B.
- ii) For intermediate-high levels of K and intermediate-high values of c (region BDO) there is no innovation and the merger is forbidden. The government chooses B.
- iii) For intermediate-high levels of K and large values of c (region AIM) the innovation is made and the merger is allowed. The government chooses A.
- iv) For large levels of K (region DO) there is no innovation and the merger is forbidden. The government is indifferent between A and B.
- v) For low levels of K and c (region DI) the innovation is made and the merger is forbidden. The government is indifferent between A and B.
- vi) For low levels of K and large levels of c (region MI) the innovation is made and the merger is allowed. The government is indifferent between A and B.

FIGURE 2
The SPE of the basic game in the (K, c) space



According to the previous result, there are cases (iv, v, and vi) where the government’s ability to choose before or after the innovation is irrelevant. However, in cases (i), (ii), and (iii) this ability becomes crucial. We will focus on those cases in the following.

COROLLARY 2 *Under Assumptions 1, 2 and 3, the SPE\ of the game presented in this section satisfies the following properties:*

- i) For intermediate-low levels of c and intermediate-low levels of K (region BMI) the government chooses a commitment to a permissive merger policy in order to ensure that innovation takes place.*
- ii) For intermediate-high values of c and intermediate-high values of K (region BDO) the government chooses a commitment to a prohibitive merger policy in order to deter socially wasteful innovation.*
- iii) For large values of c and intermediate-high values of K (region AIM) the government decides to postpone its merger policy decision after firm 1 decides about innovation.*

Parts (i) and (ii) in the previous corollary reflect the cases where the possibility of commitment is relevant. The intuition of part (i) is that for the relevant values of K and c innovation is socially desirable, but only takes place under a commitment to permissive policy since otherwise the firm anticipates the government's interest in an ex-post prohibitive policy. Regarding part (ii), the intuitive explanation relies on the idea that, in the absence of commitment, firm 1 is interested in innovating in order to manipulate the government's decision. (Note that in this case the government is interested in allowing merger *once the innovation has been adopted*). Part (iii) shows that, in some cases, the absence of commitment is socially preferred. Intuitively, although the merger is finally allowed, this policy is used by the government as a credible threat of not allowing merger if innovation does not take place.

Our previous analysis raises two interesting issues: first, the importance of commitment in the design of the optimal merger policy and, second, the role of the involved parameters in the design of such policy. According to Corollary 1, the regulator should pay special attention to those industries where the potential gains associated to innovation are important but require substantial investments. This is the case of R&D intensive industries. Our results suggest that in those industries the regulator should make an effort to distinguish between different cases, depending on the interplay between efficiency gains and the associated levels of investment. In turn this is connected with an important problem associated with the economic policy in general: the intertemporal consistency of policy decision. Sometimes the regulator would like to commit either to a permissive policy or to a prohibitive policy. Of

course the regulator cannot make a law for each firm, but there are some devices that might help to provide credibility and justification to act differently in different cases:

- i) The antitrust authority can create a reputation based on previous decisions. Our stylized one shot game does not allow to consider this explanation but in a dynamic framework this issue could be analyzed.
- ii) The antitrust authority can publish a separate note describing in detail how the different cases are considered. As indicated by Röller et al. (2001) in its report for the European Commission, issuing a notice of this type may have an important commitment value: “The increased transparency would make it difficult to deviate from the described procedure”. This second device is more consistent with our static model since it does not require a repeated game.

The results of this section remain the same, in terms of SPE, if we consider a variant of the previous game where the commitment to allow merger is conditional on firm 1 choosing the new technology (see Appendix). However, as we show in the following section, if licencing contracts are available, then the results depend crucially on whether the commitment to merger is conditional or not.

3. The model with licensing

In this section we extend the previous analysis to the case where licensing agreements between firm 1 and firm 2 are feasible.

In their recent paper, Faulí-Oller and Sandonís (2003) show that if licensing agreements with both royalties and fees are feasible, then mergers should always be forbidden, *given the technology*. We will consider the same type of agreements in our model, but with endogenous choice of technology. On the one hand, we will show that some of the basic insights of the previous section will remain. On the other hand, in contrast with the result by Faulí-Oller and Sandonís (2003), it is not always the case that a commitment to a permissive merger policy is worse than a commitment to a prohibitive one.

The structure of the game assumed in this section will be the same as in the previous section except that, now, in the case of a prohibitive policy and the choice of innovation, duopolistic competition is preceded by a licencing contract. This licencing contract is a vector (l, L) where l is the royalty paid by firm 2 to firm 1 per unit of production and L

is the fixed fee, independent of the amount produced. We will assume that the contract is a take-it-or-leave-it offer of firm 1 to firm 2.

Routinary calculations show that, after the licensing contract (l, L) has been signed, the Cournot equilibrium profits of firm 1 and firm 2, are given, respectively, by:

$$\pi^{DL} = \frac{(1+l)^2}{9} + L + l \left(\frac{1-2l}{3} \right) - K \text{ and } \pi_2^{DL} = \frac{(1-2l)^2}{9} - L.$$

The optimal offer must satisfy:

$$\pi_2^{DL} = \Pi_2^{DI} \rightarrow \frac{(1-2l)^2}{9} - L = \frac{(1-2c)^2}{9} \rightarrow L = \frac{4}{9}(c-l+l^2-c^2).$$

Thus, profit of firm 1 can be written as:

$$\pi^{DL} = \frac{(1+l)^2}{9} + \frac{4}{9}(c-l+l^2-c^2) + l \left(\frac{1-2l}{3} \right) - K.$$

Taking into account the restriction that $l \leq c \leq \frac{1}{2}$ and noticing that $\frac{\partial \pi^{DL}}{\partial l} > 0$ for $l \leq \frac{1}{2}$, it follows that the optimal royalty is given by:

$$l^R = c.$$

The previous result implies that the optimal royalty equals the cost savings associated with the new technology. Thus, the pay-offs obtained by firm 1 and the government, under duopoly with innovation, once the optimal contract is chosen, are given, respectively, by

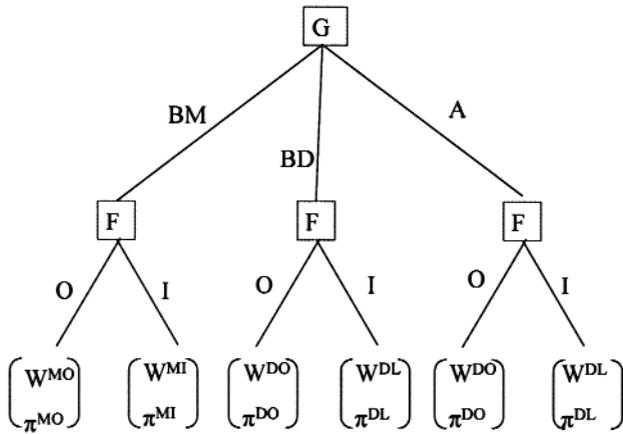
$$\pi^{DL} = \frac{1+5c-5c^2}{9} - K; \quad W^{DL} = \frac{8-2c-c^2}{18} - K. \quad [5]$$

Once the technology has been chosen, the dominant government's strategy is to forbid the merger. In terms of our model, this implies that we can simplify our analysis by considering the reduced form of the game shown in Figure 3, where we assume that commitment to a permissive merger policy is not conditional on innovation.

The SPE of this game satisfies the following proposition.

PROPOSITION 3 *Under Assumptions 1, 2 and 3, if commitment to a permissive policy cannot be conditional on innovation, then at the SPE of the game with licensing the government will always prohibit the merger (regardless of the technological choice).*

FIGURE 3
The licensing game with no conditioning

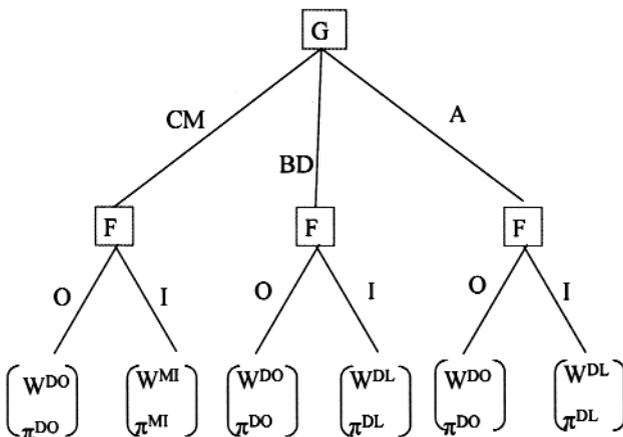


This result seems to indicate that the policy implication obtained by Faulf-Oller and Sandonís (2003) under exogenous technology remain with endogenous innovation. However, we will show in the following analysis that this is not the case if the commitment to allow the merger can be made conditional on innovation.

3.1 *The model with conditional commitment*

Now let us consider a variant of the previous game where commitment to allow merger is conditional on firm 1 choosing the new technology.

FIGURE 4
The licensing game with conditioning



In this case, the reduced form of the game with licensing becomes as in Figure 4, where CM stands for the commitment to allow merger conditional on the new technology.

The main conclusion of this section is the following

PROPOSITION 4 Under Assumptions 1, 2 and 3, the SPE of the game presented in this section involves a commitment to a permissive merger policy (conditional on choosing the new technology) for high enough values of c and intermediate levels of K . In the rest of the cases the optimal policy is a prohibitive one.

The previous result shows that when technological innovation is endogenous, then there are cases where committing to a permissive merger policy conditional on innovation is better than licensing in terms of welfare, even if licencing agreements allow for both royalties and fees. In other words, there are cases where licensing is not enough to make innovation attractive, and the merger becomes the only way to ensure socially profitable innovations.

Note that the result in proposition 1 raises again commitment problems associated with merger policy. In particular, it identifies cases where allowing for the merger conditional on innovation is optimal. However this policy is not time consistent: once the innovation takes place the government would be interested in forbidding the merger. Nevertheless, we think that there are commitment devices of the type discussed in the previous section that might ensure the credibility of the government's decision.

4. Conclusions

We have considered a multistage game where both innovation and merger policy are endogenous decisions. In a context where licencing contracts are not available, we identify the conditions under which the optimal merger policy involves (i) precommitment to a permissive policy to ensure the innovation, (ii) precommitment to a prohibitive policy to deter the innovation or (iii) a policy without commitment, devoted to stimulating innovation.

We remark that, in case (iii), the lack of commitment is used by the antitrust authority as a credible threat of challenging merger if innovation is not undertaken, which guarantees that innovation takes place in equilibrium. This case does not involve special problems regarding

the implementation of the optimal merger policy, since it fits the conventional analysis where the antitrust authority takes the technology as given.

The commitment problem is more complex in cases (i) and (ii). In case (i) the government must commit to allow a merger which is welfare increasing *ex-ante* but not *ex-post*, while in case (ii) it must commit to reject a merger which is welfare increasing *ex post* (in the case of innovation). In the previous section we have emphasized the importance of publishing detailed merger rules in order to ensure the credibility of merger policy in those cases.

Our analysis is extended to allow for licencing contracts as an alternative tool for technology transfer. In contrast with recent literature, we show that there are cases where a merger with innovation is socially preferred to a duopoly without innovation (and without licensing) even if the licensee has the possibility to choose both royalties and fees.

In order to focus on the strategic interactions between merger policy and innovation investments, we have ignored other important aspects of industrial policy, such as subsidies on innovation². We have also ignored other questions that would complicate the analysis without changing the main insights. For instance, we have assumed that the acquiring firm has all the bargaining power. If instead we consider a more general bargaining set up where the acquisition price is greater than the acquired firm's reservation pay-off, then the incentives to innovate will be smaller. However it is easy to see that our basic results hold, in this more general model, for sufficiently high bargaining power of the acquiring firm.

So far we have interpreted our model in terms of technological innovation. However, among other interpretations, the investment to reduce marginal costs can also be interpreted as investment in physical capital, learning by doing, or it can be associated with the structure of contracts with input suppliers. Under this wider interpretation, our results emphasize that the ability (or convenience) of the antitrust authority to reach a precommitment to either a prohibitive or a permissive policy is a crucial issue. In this sense our paper is an attempt

²Note that in principle innovation subsidies dominate merger policy as a device to stimulate innovation since this alternative policy does not reduce competition. However this is not necessarily true if there are social costs associated to subsidies. Those social costs might be due, for instance, to distorsionary taxation or the costs of monitoring.

to contribute, in a simplified merger policy game, to the analysis of the general problem of the intertemporal consistency of economic policy. The importance of this problem was stressed, among others, by Kydland and Prescott (1977). However, as pointed out by Karp and Lee (2003) there is a surprising lack of research regarding this important aspect of economic policy.³

In fact it seems to us that the merger policy carried out in some countries tends to ignore the important role of commitment when firms' long run decisions are involved. As an illustrative example, the recent decision by the Spanish government to allow the merger between the two main Spanish digital TV platforms, was taken clearly after important strategic decisions by the platforms had been carried out. In particular, a crucial aspect of those decisions involves long run contracts with input suppliers that, once having been signed, tend to make a merger proposal more convenient ex-post than it would have been ex-ante.⁴ Our model suggests that perhaps a more credible commitment to a prohibitive policy could have deterred such decisions.⁵

³A remarkable exception is the recent contribution by Petkov (2003) in the context of learning by doing. This author points out the government's lack of ability to commit to non-intervention as a source of inefficiently low levels of learning by doing investment. However, in contrast with our paper, this contribution does not consider the possibility that firms use long run commitments to force ex-post mergers that ex-ante are inefficient.

⁴In fact, this is the main explicit argument used by the Spanish antitrust authority in its sentence, to justify the efficiency gains associated with this merger. (See TDC, 2002, p. 174).

⁵Interestingly, other argument used by the Spanish antitrust authority to justify the merger among the two digital platforms is based in the so so-called *failing firm defense*. Under this rule (considered both in the US and in the recent EU merger regulations) a merger can be allowed if the acquired firm is almost certain to go bankrupt. In terms of our model, this failing firm defence might create an extra incentive for the acquiring firm to worsen its competitor's position and force a permissive merger policy. In a similar spirit Persson (2003) has shown that an inappropriate regulation of the failing firm defense might create wasteful predation incentives prior to the merger. In his model the wasteful investments are intended to lower the acquisition price of the prey, while in our context they are intended to manipulate the regulator's choice.

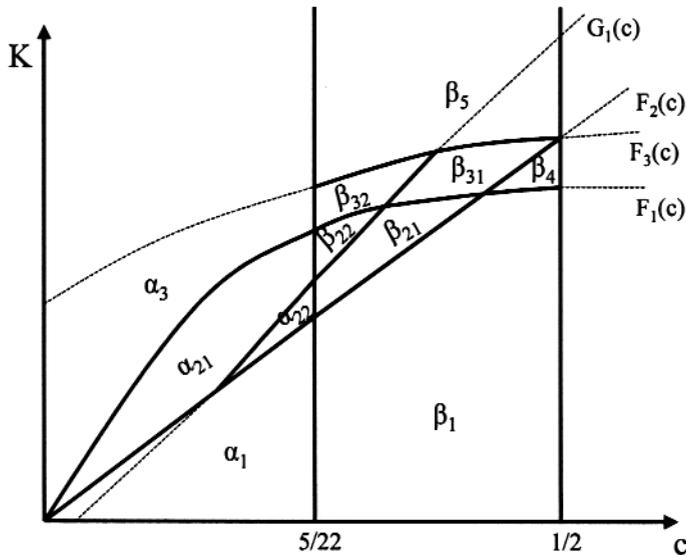
Appendix A1. Proofs

A1.1 Proof of Proposition 1:

To simplify the analysis, it is useful to note the following facts:

Firstly, if the government chooses *BM* then the subgame perfect equilibrium (SPE) always implies a monopoly, while choosing *BD* always yields a duopoly.

FIGURE A.1



Secondly, if the government chooses *A*, and firm 1 chooses *O*, then the SPE implies a duopoly, since $W^{DO} > W^{MO}$.

Thirdly, if the government chooses *A*, and firm 1 chooses *I*, then government chooses *D* at stage 3 if $W^{DI} > W^{MI}$. This condition is satisfied if and only if $c \leq 5/22$ (which will be denoted by case α), otherwise it chooses *M* (denoted by case β).

Let us solve for the SPE of the game. The following cases and subcases are reflected in figure A.1 in the (c, K) space.

Case α : $c \leq 5/22$. Note the following:

Firstly, if the government chooses *BM*, then firm 1 chooses *I* if

$$\pi^{MI} - \pi^{MO} > 0 \iff F_1(c) \equiv \frac{(26c - 21c^2)}{36} > K \quad [A.1]$$

and *O* otherwise.

Secondly, if the government chooses A , or BD , then firm 1 chooses I if

$$\pi^{DI} - \pi^{DO} > 0 \iff F_2(c) \equiv \frac{4c}{9} > K \quad [\text{A.2}]$$

and O otherwise.

Since $F_1(c) > F_2(c)$, in this case α , we have the following subcases:

Subcase α_1 : $K < F_2(c)$. To choose I is the dominant strategy for firm 1, thus government chooses either A , or BD , since we know that in these cases $W_{DI} - W_{MI} > 0$. Thus, there are two subgame perfect equilibria given by the sets of actions (A, I, D) and (B, D, I) .

Subcase α_2 : $F_1(c) > K > F_2(c)$. Firm 1 chooses O if government chooses either A or BD ; otherwise it chooses I . Thus, the government's optimal choice is BM if

$$W^{MI} - W^{DO} > 0 \iff G_1(c) \equiv \frac{3}{8} - \frac{4}{9}(1-c)^2 > K \quad [\text{A.3}]$$

and A otherwise. Since $F_1(c) > G_1(c)$ for any $c \leq 5/22$, we have two subcases for α_2 :

Subcase α_{21} : If $F_1(c) > K > G_1(c)$ then the subgame perfect equilibria are (A, O, D) and (B, D, O) .

Subcase α_{22} : If $F_1(c) > G_1(c) > K > F_2(c)$ then the SPE implies (B, M, I) . This subcase is only possible if $c > 0.19$.

Subcase α_3 : $F_1(c) < K$. Choosing O is the dominant strategy for firm 1. Thus, government chooses either A , or BD since $W_{MO} - W_{DO} < 0$. Therefore, the subgame perfect equilibria are (A, O, D) and (B, D, O) .

Case β : $c \geq 5/22$. Note the following:

First, if government chooses BM , then firm 1 chooses I if

$$\pi^{MI} - \pi^{MO} > 0 \iff F_1(c) > K$$

and O , otherwise.

Second, if government chooses A then firm 1 chooses I if

$$\pi^{MI} - \pi^{DO} > 0 \iff F_3(c) \equiv \frac{(1 + 24c - 20c^2)}{36} > K \quad [\text{A.4}]$$

and O otherwise.

Third, if the government chooses BD then firm 1 chooses I if

$$\pi^{DI} - \pi^{DO} > 0 \iff F_2(c) > K$$

and O otherwise.

Since $F_3(c) > F_1(c)$, we have the following subcases:

Subcase β_1 : $K < \min\{F_1(c), F_2(c)\}$. Choosing I is the dominant strategy for firm 1, thus government is indifferent between BM and A and in both cases the outcome is a monopoly. The first SPE implies (A, I, M) and the second (B, M, I) .

Subcase β_2 : $F_2(c) < K < F_1(c)$ Firm 1 chooses I if the government chooses A or BM , and O otherwise. Thus, government will choose either BM or A if

$$W^{MI} - W^{DO} > 0 \iff G_1(c) > K$$

and BD otherwise. We have two subcases for β_2 :

Subcase β_{21} : $F_2(c) < K < \min\{F_1(c), G_1(c)\}$. The government chooses either BM or A , while firm 1 chooses I . Thus the subgame perfect equilibria are given by (B, M, I) and (A, I, M) .

Subcase β_{22} : $G_1(c) < K < F_1(c)$. The government chooses BD , while firm 1 chooses O . Thus, SPE implies (B, D, O) .

Subcase β_3 : $\max\{F_1(c), F_2(c)\} < K < F_3(c)$. Firm 1 chooses I if government chooses A and O otherwise. There are two subcases for β_3 :

Subcase β_{31} : $\max\{F_1(c), F_2(c)\} < K < \min\{F_3(c), G_1(c)\}$. The government chooses A and firm 1 chooses I . Thus the SPE is given by (A, I, M) .

Subcase β_{32} : $\max\{F_1(c), G_1(c)\} < K < F_3(c)$. The government chooses BD and firm 1 chooses O . Thus the SPE is given by (B, D, O) .

Subcase β_4 : $F_1(c) < K < F_2(c)$. Firm 1 chooses O if the government chooses BM , otherwise it chooses I . Thus the government chooses A and the SPE is given by (A, I, M) .

Subcase β_5 : $K > F_3(c)$. To choose O is firm 1's dominant strategy. Thus the government is indifferent between choosing A and choosing BD and the two subgame perfect equilibria are given by (A, O, D) and (B, D, O) .

Table A.1 shows the subgame perfect equilibria (SPE) at each region in Figure 3.

TABLE A1
The SPE in each region

Region	SPE
α_1	(A, I, D) and (B, D, D)
α_{21} and α_3	(A, O, D) and (B, D, O)
α_{22}	(B, M, D)
β_1 and β_{21}	(A, I, M) and (B, M, D)
β_{22} and β_{32}	(B, D, O)
β_{31} and β_4	(A, I, M)
β_5	(A, O, D) and (B, D, O)

The previous results remain the same, in terms of SPE, if we consider that commitment to allow merger is conditional to firm 1 choosing the new technology. To see this, note that if the government chooses M , conditional to innovation, then firm 1 will innovate if and only if $\pi^{MI} > \pi^{DO} \leftrightarrow K < F_3(c)$. On the other hand, when the choice of M is not conditional then firm 1 innovates if and only if $\pi^{MI} > \pi^{MO} \leftrightarrow K < F_1(c)$, but $F_3(c) > F_1(c)$ which implies that if innovation takes place in the scenario without conditioning then it will also take place under conditioning.

A1.2 Proof of Proposition 2:

To solve for the SPE of the game with licensing, note the following:

First, the government is indifferent between choosing A or BD .

Second, $\pi^{DL} < \pi^{MI}$.

Therefore, we have the following cases:

i) $\pi^{DL} < \pi^{DO} \leftrightarrow K > \frac{c(7-6c)}{9} \equiv F_L(c)$. Since $F_1(c) < F_L(c)$ this implies that choosing O is the dominant strategy of firm 1 (recall that $K > F_1(c)$ implies $\pi^{MO} > \pi^{MI}$). Thus government is indifferent between A and BD and the subgame perfect equilibria are (A, O, D) and (B, D, O) .

ii) $F_1(c) < K < F_L(c)$. Firm 1 chooses I if merger is not allowed, otherwise it chooses O . On the other hand $W^{DL} > W^{MO} \leftrightarrow G_L(c) \equiv \frac{5+46c-31c^2}{72} > K$ and $G_L(c) > F_L(c)$. Thus the government chooses BD or A and the subgame perfect equilibria are: (B, D, I) and (A, I, D) .

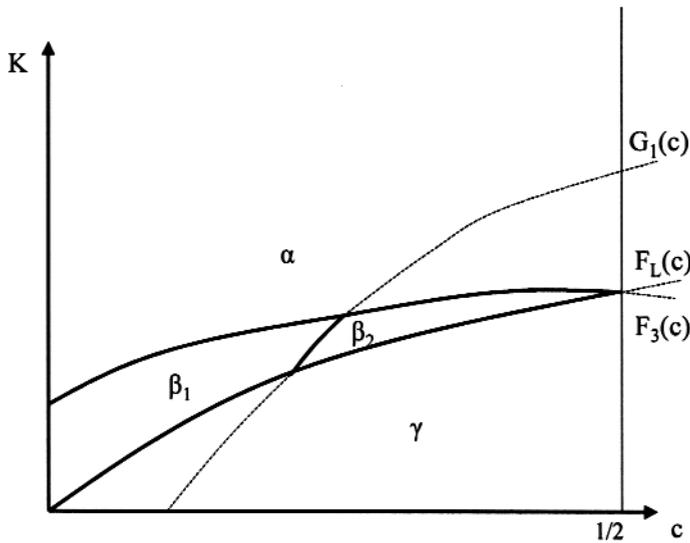
iii) $K < F_1(c)$. In this case choosing O is the dominant strategy of firm 1. Thus government chooses either A or BD and the subgame perfect equilibria are (A, I, D) and (B, D, I) .

A1.3 Proof of proposition 3:

To solve for the SPE of the game with licensing under the new assumption, recall that, as in the previous analysis, the government is indifferent between choosing A or BD , and $\pi^{DL} < \pi^{MI}$.

Therefore, we have the following cases, represented in Figure A.2:

FIGURE A.2



Case α : $\pi^{MI} < \pi^{DO} \leftrightarrow K > F_3(c)$. In this case, choosing O is the dominant strategy of firm 1. Thus the government chooses either A or BD and the subgame perfect equilibria are (A, O, D) and (B, D, O) .

Case β : $\pi^{DL} < \pi^{DO} < \pi^{MI} \leftrightarrow \frac{c(7-6c)}{9} \equiv F_L(c) < K < F_3(c)$. Firm 1 chooses I if merger is allowed and O otherwise. The government chooses A or BD if and only if $W^{DO} > W^{MI} \leftrightarrow K > \frac{64c-32c^2-5}{72} \equiv G_1(c)$, otherwise it chooses BM . Thus we have two subcases:

Subcase β_1 : $\max\{G_1(c), F_L(c)\} < K < F_3(c)$. The subgame perfect equilibria are (A, O, D) and (B, D, O) .

Subcase β_2 : $F_L(c) < K < \min\{G_1(c), F_3(c)\}$. The SPE is (C, M, I) .

Case $\gamma : \pi^{DO} < \pi^{DL} \leftrightarrow K < F_L(c)$. To choose I is the dominant strategy of firm 1. Thus the government chooses either A or BD and the subgame perfect equilibria are (A, I, D) and (B, D, I) .

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Resumen

En este trabajo consideramos las interacciones entre innovación y política de fusiones bajo diferentes supuestos sobre la transferencia de tecnología. En ausencia de contratos de licencias, demostramos que en algunos casos el gobierno debe comprometerse a una política permisiva para asegurar que innovaciones socialmente deseables tienen lugar, mientras que en otros casos debe comprometerse a una política prohibitiva para disuadir inversiones excesivas en innovación. También identificamos circunstancias en las que la ausencia de compromiso es socialmente necesaria para asegurar que tiene lugar la innovación, aunque la fusión sea finalmente permitida. En contraste con la literatura reciente sobre licencias, demostramos que una política de fusiones permisiva puede ser óptima incluso si las licencias de transferencia de tecnología constan tanto de una cuota fija ("fee") como de una parte variable ("royalty").

Palabras clave: Política de fusiones, innovación, licencias.

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