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MERGER POLICY IN R&D INTENSIVE INDUSTRIES*

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We analyze merger policy in an industry where firms participate in a non-tournament R&D competition. We conclude that merger policy should be, in general, less restrictive in high technology markets (pharmaceuticals and telecoms), because mergers reduce the wasteful duplication of R&D expenditures. However, merger policy should become more strict in (very) asymmetric market structures. In this case, competition provides incentives for R&D, but, at the same time, duplication is avoided.

Key words: mergers, R&D.

JEL Classification: L13, L41.

At least since Williamson (1968), it has been recognized that horizontal mergers involve a trade-off. On the one hand, they increase market power, but, on the other hand, they may allow merging firms to reduce costs. For example, in a setting where firms compete in quantities with constant but asymmetric marginal costs, a merger between a low cost firm and a high cost firm allows firms to reduce costs by transferring output from the high cost firm to the low cost firm. This merger will increase social welfare if the cost reduction is important enough i.e. if the cost difference between merging firms is high enough [Lahiri and Ono (1988)].

In this paper we analyze how merger policy should be adapted when, apart from quantities, firms also choose the level of cost reducing R&D investments. We consider the case of an asymmetric duopoly and we want to check whether it is still true that a merger increases welfare if the cost difference between firms is high.

When firms also compete in R&D we must take into account the following. On the one hand, competition may lead to an excessive expenditure in R&D because cost reducing efforts are duplicated [Lee and Wilde (1980)]. On the other hand, the merger to monopoly may reduce the incentives to innovate below the socially efficient level.

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We study the impact of market structure on the incentives of making R&D. Therefore, we consider a model where merger decisions are taken before investments in R&D. We could consider the case where R&D decisions are taken before merger decisions as in Cabolis et al (2008). However, we think that the timing we propose is more reasonable, because mergers involve a more long run decision than R&D decisions[1].

Our analysis considers two different cases: the strategic and the non-strategic case. In the non-strategic case, R&D and output decisions are taken simultaneously and therefore R&D decisions are only driven by cost reducing considerations. In the strategic case, firms set first their R&D expenditures and then their production levels (both non-cooperatively). In that situation, the firms can use their R&D investments to affect the decisions of the competitors. By comparing the two contexts we isolate the strategic role played by R&D expenditures.

In the non-strategic case, we have the same result as the one when firms only competed in quantities: the merger increases welfare when cost differences are high enough. The only difference is that the cost difference required for a merger to increase welfare decreases as the level of R&D increases. Therefore, merger policy should be less strict in R&D intensive industries.

In the strategic case, the rule that defines the optimal merger policy changes. Mergers should be approved if the cost difference between firms takes intermediate values. The surprising part of this result is that a merger including a very inefficient firm reduces welfare. The competition provided by the inefficient firm has a positive effect. On the one hand, it stimulates the R&D of the efficient firm. On the other hand, the asymmetry guarantees that this is done without duplication of R&D, because as it produces very little has very little incentives to spend in R&D. We have cases where the inefficient firm does not produce but the merger would reduce welfare. It is an extreme case of what we are saying, the presence of the inefficient firm stimulates the investment of the efficient one while duplication is avoided.

Stenbacka (1992) also studies the effect of merger decisions on the level of cost-reducing investment by firms. He considers a duopoly but only one firm can invest. Then, the merger has not the beneficial effect it has in our setting of avoiding the duplication of investments and he obtains that all mergers reduce social welfare.

Next we present two merger cases where the effect of mergers on innovation played a key role in the decision of antitrust authorities on whether to challenge or approve a given merger. [The examples are taken from Katz and Shelanski (2007)]. They highlight the importance of our paper that studies how merger policy should be adapted in R&D intensive industries.

The first example was the decision of the Department of Justice (DOJ) to challenge the merger, in 1993, between ZF Friedrichshafen (ZF) and the General Motors's Allison Division. They produced the 85% of the world output of heavy-duty automatic transmissions for trucks and buses. Despite this high percentage, they did not compete in all markets. For example, they did not compete in North America in which GM was dominant. But even in the markets where it did not raise anticom-

(1) Davidson and Ferrett (2007) also consider that the merger decision is taken before the R&D investments.

petitive concerns the DOJ considered that the merger would be bad because it would reduce the incentive of firms to innovate. The merger was later abandoned.

The second example was the decision in 2004 by the Federal Trade Commission (FTC) to approve the merger between Genzyme and Novazyme, the only two companies with therapies for a rare disorder known as Pompe disease. The case is important because the decision was mainly based on the innovation impact of the merger, leaving aside questions about price and short-term competition. The merger was approved because the FTC concluded that innovation could benefit from the merger.

The decisions taken by antitrust authorities in the two cases we have presented are contradictory. In the ZF/Allison case the merger is assumed to reduce innovation while in the Genzyme/Novazyme case the merger is assumed to stimulate innovation. This highlights the fact that we are far from a general consensus on how to apply competition policy in R&D intensive industries.

Nevertheless, the message of the present paper is that the competition provided by small firms must be preserved. This idea is included in the European Merger Guidelines [ECMG (2004)] in its paragraph 38 where it states “a firm with a relatively small market share may nevertheless be an important competitive force if it has promising pipeline products”.

In Section 1, we consider the nonstrategic model that serves us a benchmark from which to compare the results obtained in the strategic model, that is analyzed in Section 2. Finally, conclusions are presented in Section 3.

1. Benchmark non-strategic model

We have two firms, firm 1 and 2, competing in a market with inverse demand given by p = A-Q where Q is total output and p is price. Firm i’s cost function is assumed to be of the form:

$$C_i(x_i, q_i) = (c_i - q_i)q_i + \gamma x_i^2$$

where x_i and q_i denote the level of R&D and the production of firm i respectively. The R&D is a process (cost-reducing) innovation that by spending x_i^2 in R&D, the marginal cost of production will be reduced from c_i to $c_i - x_i$, and the firm faces a trade-off between paying a lump-sum cost of x_i^2 and benefiting a lower marginal cost of $c_i - x_i$.

We assume that Firm 1 is more efficient, $c_1 < c_2$. This cost function corresponds to the one used in d’Aspremont and Jacquemin (1988) for the case without spillovers[2].

It is assumed that γ□ 1. This guarantees that the second order conditions are satisfied. Observe that represents the effectiveness of R&D investment. When γ increases the expenditure to obtain a given cost reduction also increases. The case without R&D investment is obtained in the limit case when tends to infinity.

(2) Introducing spillovers will lead us naturally to consider intermediate forms of competition as Research Joint Ventures. To focus on the comparison between full competition and full cooperation, we prefer to suppress spillovers in the specification of the cost function.

Firms decide both the level of R&D and the level of output. We will consider two different scenarios depending on the timing of the decisions.

In this Section, we study the Non Strategic model where all decisions are taken in the same stage. In the next Section, we consider the Strategic model where we have a two stage game where in a first stage, the R&D decisions are taken and once they are publicly known, output decisions are taken in a second stage. The difference between both models lies in the role played by R&D decisions. In the first model, they are driven only by cost reducing considerations. In the second, we must also take into account the influence they have on market competition in the second stage. These two scenarios are common in the literature dealing with R&D competition.

To solve the model we define the profits of firm 1 and 2. To save notation, we set, without loss of generality, $A - c_1 = 1$. Then profits are given by:

$$\pi_1 = (1 + x_1 - q_1 - q_2)q_1 - \gamma x_1^2$$

$$\pi_2 = (1 - t + x_2 - q_1 - q_2)q_2 - x_2^2$$

where $t = c_2 - c_1$.

Higher values of t represent higher asymmetries between firms. Results will depend on two parameters namely γ (the effectiveness of R&D) and t (the degree of asymmetry between firms).

1.1. Pre-merger situation

In equilibrium, the quantities and R&D investment are given respectively by:

$$q_1^N = \frac{\left(2\gamma\left(-1 + 2\gamma(1 - t)\right)\right)}{(1 - 8\gamma + 12\gamma^2)}$$

$$q_2^N = \frac{\left(2\gamma\left(-1 + 2\gamma + t(1 - 4\gamma)\right)\right)}{(1 - 8\gamma + 12\gamma^2)}$$

$$x_1^N = \frac{\left(\left(-1 + 2\gamma(1 - t)\right)\right)}{(1 - 8\gamma + 12\gamma^2)}$$

$$x_2^N = \frac{\left(\left(-1 + 2\gamma + t(1 - 4\gamma)\right)\right)}{(1 - 8\gamma + 12\gamma^2)}$$

when $t \leq \frac{2\gamma-1}{4\gamma-1}$. Otherwise, we have the same situation as with merger analyzed in Section 2.2.

The efficient firm invests in R&D more than the inefficient one. The difference between the level of investments increases with the degree of asymmetries (t). When $t \geq \frac{2\gamma-1}{4\gamma-1}$, the inefficient firm does not invest and does not produce.

Social welfare is assumed to be the sum of consumer surplus and firms profits. Given outputs q_1 and q_2, and R&D levels x_1 and x_2 it is given by:

$$W(q_1,q_2,x_1,x_2,\gamma)=\int_0^{q_1+q_2}(A-y)\,dy-(c_1-x_1)q_1-(c_2-x_2)q_2-\gamma(x_1)^2-\gamma(x_2)^2=$$

$$=A(q_1+q_2)-\frac{(q_1+q_2)^2}{2}-(c_1-x_1)q_1-(c_2-x_2)q_2-\gamma(x_1)^2-\gamma(x_2)^2$$

Therefore the social Welfare in the non-strategic equilibrium where both firms are active amounts to:

$$W^N=\frac{\left(\gamma\left(2(1-t)(1-2\gamma)^2(-1+8\gamma)+t^2(-1+14\gamma-60\gamma^2+88\gamma^3)\right)\right)}{((1-6\gamma)^2(1-2\gamma)^2)} \qquad [1]$$

1.2. Post-merger situation

To study what happens when both firm merge to form a monopoly, we have to specify the cost function of the merged entity.

We consider that the cost structure is not altered by the merger[3], that is

$$C(x_1,x_2,q_1,q_2,)=(c_1-x_1)q_1+(c_2-x_2)q_2+\gamma(x_1^2+x_2^2)$$

This implies that R&D and production will be concentrated in the most efficient firm. The merged firm will optimally choose $q_2 = 0$ and $x_2 = 0$.

In equilibrium the merged entity will produce:

$$q^M=\frac{2\gamma}{4\gamma-1}$$

and the optimal level of R&D will be:

$$x^M=\frac{1}{4\gamma-1}$$

The merger increases the level of R&D with respect to the level of investment of Firm 1 in dupoly.

Social Welfare with merger is given by:

$$W^M=\frac{(6\gamma-1)\gamma}{(4\gamma-1)^2} \qquad [2]$$

(3) Observe that this means that the research developed in firm 2 can not be used to reduce the cost of producing the good in firm 1.

1.3. *Optimal merger policy*

In this section we derive the optimal merger policy. If $t \geq \frac{-1+2\gamma}{-1+4\gamma}$ we have monopoly in any case. Therefore merger policy is not an issue so that results below concentrate on the remaining values of t.

The optimal policy results from comparing expression [2] with [1] leading to the results stated in proposition 1.

Proposition 1. In the non strategic case merger increases welfare when asymmetries are high enough, $t \geq t^N(\gamma)$ where $\frac{dt^N(\gamma)}{d\gamma} > 0$ and

$$t^N(\gamma) = \frac{1 - 16\gamma + 80\gamma^2 - 144\gamma^3 + 80\gamma^4}{1 - 18\gamma + 116\gamma^2 - 328\gamma^3 + 352\gamma^4}$$

This proposition confirms the result obtained in markets without R&D that inefficient firms are prejudicial for welfare[4] [Lahiri and Ono (1988)]. In these cases, welfare will increase if inefficient firms merge with more efficient firms. However, merger policy should be adapted in R&D intensive industries because the greater the effectiveness of R&D, the smaller the degree of asymmetry between firms needed for a merger to increase welfare. This result comes from the fact that $\frac{dt^N(\gamma)}{d\gamma} > 0$.

2. Strategic model

2.1. *Pre-merger situation*

We solve first the case where both firms are active. This will be the case when firms are not very asymmetric $\left(t \leq \frac{3\gamma-2}{2(-1+3\gamma)}\right)$. Given the investments in the first stage x_1 and x_2, outputs of firms in the second stage will be:

$$q_1 = \frac{\left((1+t) + 2x_1 - x_2\right)}{3}$$

$$q_2 = \frac{\left((1-2t) - x_1 + 2x_2\right)}{3}$$

In the first stage (or R&D stage) the optimal level of R&D is given by:

$$x_1^S = \frac{(-4 + 6(1+t)\gamma)}{4 - 24\gamma + 27\gamma^2}$$

$$x_2^S = \frac{(-4 + t(4 - 12\gamma) + 6\gamma)}{4 - 24\gamma + 27\gamma^2}$$

(4) Observe that the case without R&D can be obtained in our model by letting tend to infinity. In this case merger increases welfare when $t \geq \frac{5}{22}$.

These levels of R&D depend on the degree of asymmetries (t) and the effectiveness of R&D (γ).

Therefore the quantity produced in equilibrium is:

$$q_1^S = \frac{3\gamma(-2+3(1+t)\gamma)}{4-24\gamma+27\gamma^2}$$

$$q_2^S = \frac{3\gamma(-2+t(2-6\gamma)+3\gamma)}{4-24\gamma+27\gamma^2}$$

The efficient firm invests in R&D more than the inefficient one. The difference between the level of investments increases with the degree of asymmetries (t) When. $t = \frac{3\gamma-2}{2(-1+3\gamma)}$, the inefficient firm does not invest and does not produce. Observe that the inefficient firm is expelled from the market for a lower value of t in the strategic case than in the non strategic case. The reason for this is that now the R&D decisions have a strategic dimension: the efficient firm overinvests in order to reduce the output sold in Stage 2 by firm 2.

Social Welfare in equilibrium is given by:

$$W^S = \frac{\gamma\left(8(1-t)(2-3\gamma)^2+t^2(16-78\gamma+99\gamma^2)\right)}{2(2-3\gamma)^2(-2+9\gamma)} \qquad [3]$$

When $\frac{3\gamma-2}{2(-1+3\gamma)} \leq t \leq \frac{-1+2\gamma}{-1+4\gamma}$ firm 1 invest in R&D to expel firm 2 from the market. In this case

$$x_2^S = q_2^S = 0$$

and

$$x_1^S = (1-2t) \text{ and } q_1^S = (1-t)$$

$$W^S = \frac{3}{2} - 3t + \frac{3}{2}t^2 - \gamma + 4t\gamma - 4\gamma t^2. \qquad [4]$$

When $t \geq \frac{-1+2\gamma}{-1+4\gamma}$, we have the same situation as with merger.

2.2. Post-merger situation

We have the situation as the one analyzed in Section 2.2. In the strategic case, the merger reduces the investment of firm 1 if

$$\left(\frac{1}{6\gamma}\right)\left[\frac{4-24\gamma+27\gamma^2}{\gamma-1} + 4 - 6\gamma\right] < t.$$

i.e. if firm 2 is inefficient enough. There has been a long debate on the effect of competition on innovation. We obtain that the effect is positive if the degree of asymmetries between firms is high enough. Nevertheless, in any case the merger increases market price.

2.3. *Optimal merger policy*

In the strategic case the optimal policy results from comparing expression [2] with [3] for $t \leq \frac{3\gamma-2}{2(3\gamma-1)}$ and [2] with [4] for $\frac{3\gamma-2}{2(3\gamma-1)} \leq t \leq \frac{2\gamma-1}{4\gamma-1}$. These comparisons lead to the results stated in proposition 2.

Proposition 2. In the strategic case merger increases welfare for the intermediate values of the asymmetries $\underline{t}(\gamma) \leq t \leq \bar{t}(\gamma)$

$$\bar{t}(\gamma) = \frac{(3\gamma-2)\left(48\gamma^2 - 44\gamma + 8 + \sqrt{2\gamma(-20 + 136\gamma - 243\gamma^2 + 162\gamma^3)}\right)}{(-1+4\gamma)(16 - 78\gamma + 99\gamma^2)}$$

$$\underline{t}(\gamma) = \frac{(3\gamma-2)\left(48\gamma^2 - 44\gamma + 8 - \sqrt{2\gamma(-20 + 136\gamma - 243\gamma^2 + 162\gamma^3)}\right)}{(-1+4\gamma)(16 - 78\gamma + 99\gamma^2)}$$

Observe that in the strategic case the presence of very inefficient firms can have a positive effect on welfare. In monopoly, the level of R&D is insufficient. Then, the competition provided by an inefficient firm has a positive effect. On the one hand, it stimulates the R&D of the efficient firm. On the other hand, the asymmetry guarantees that this is done without duplication of R&D, because the inefficient firm as it produces very little has very little incentives to spend in R&D.

Observe that for $\underline{t}(\gamma) < \frac{3\gamma-2}{2(3\gamma-1)} \leq t \leq \frac{2\gamma-1}{4\gamma-1}$, even though firm 2 does not produce in the duopoly equilibrium the merger would reduce welfare. This is the extreme case of what we are saying: firm 2 stimulates the R&D investment of firm 1 and we have no duplication, because firm 2 does not invest in R&D.

Comparing the results in section 2.3 with the ones in section 3.3 we have that merger policy should be more restrictive in the strategic case. It is possible to check that $t^N(\gamma) < \underline{t}(\gamma)$. The reason is that welfare in duopoly is greater in the strategic case than in the non-strategic case. This result was identified by Brander and Spencer (1983) for the symmetric case. We check that it also holds in the asymmetric case.

3. Conclusions

The result that increases in concentration may increase social welfare due to the reduction in the duplication of R&D expenditures, connects our paper with the schumpeterian theories. It has been studied in previous papers. Therefore, we consider that our main contribution to the literature is the idea that this approach may fail in asymmetric market structures.

When we have an efficient and an inefficient firm, it is convenient to preserve competition (forbid the merger). In monopoly, the level of R&D is insufficient. Then, the competition provided by an inefficient firm has a positive effect. On the one hand, it stimulates the R&D of the efficient firm. On the other hand, the asymmetry guarantees that this is done without duplication of R&D, because the inefficient firm as it produces very little has very little incentives to spend in R&D.

As the setting looks intriguing, it looks promising to generalize it in several directions:

– The most obvious one is to try to solve the model for more than two firms. This will allow us to study the type of mergers that are more likely to increase social welfare: either the ones with symmetric partners or the ones with asymmetric ones.
– One can also introduce product differentiation. In this case, while keeping the present formulation, the expenditure in R&D could be reinterpreted as if it affected the quality of goods. Furthermore, product differentiation will allow us to consider the case of Bertrand competition.
– One could also introduce the possibility that the expenditure in R&D is used either to reduce costs (process innovation) or to increase the quality of goods (product innovation). This can be used to test the empirical evidence that shows that big firms invest more in process innovation inventions while small firms are more inclined to carry out product innovations investments [Rosen (1991) and Yin and Zuscovitch (1998)].

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RESUMEN

En este artículo se analiza la política de fusiones óptima en una industria donde las empresas realizan gastos en I+D. Concluimos que la política de fusiones debe ser, en general, menos restrictiva en mercados de alta tecnología (como, por ejemplo, la industria farmacéutica o la de telecomunicaciones), porque las fusiones reducen la duplicación ineficiente de los gastos en I+D. No obstante, la política de fusiones debe ser más estricta en estructuras de mercado muy asimétricas. En este caso, la competencia da incentivos para realizar I+D pero, al mismo tiempo, se evita la duplicación de los gastos.

Palabras clave: Fusiones, I+D.

Clasificación JEL: L13, L41.