# Horizontal Mergers and Acquisitions with endogenous efficiency gains*

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**Abstract**

Contrary to the theoretical literature for horizontal M&A where the efficiency gains are assumed to be exogenous, this paper examines the circumstances under which, long-run strategic decisions in cost-reducing R&D investments, prior to the decision for integration, induce endogenous cost asymmetries and efficiency gains that make a horizontal integration profitable. In particular, we show that firms' incentives for horizontal M&A depend on the distribution of the integrated entity's profits and on the magnitude of the efficiency gains that the participants exploit.

**JEL classification:** G34; L41; O31

**Keywords:** Horizontal mergers and acquisitions; Endogenous efficiency gains; Processes Innovations; Antitrust policy.

## 1 Introduction

Horizontal mergers and acquisitions (M&A) have been extensively used by firms as vehicles for growth and competitiveness strengthening within the context of the global economy.

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In the largest cross-national comparison of the effects of M&A that has been carried out to date, Gugler et al. (2003) find that almost 42% of the completed 45,000 mergers around the world during 1981-1998 was horizontal. They also identify horizontal mergers that increase profits by increasing efficiency.

Röller et al. (2001) present a typology of possible efficiency gains in horizontal M&A and Straume (2003) underlines that the most commonly indicated source of efficiency gains is the presence of cost asymmetries across participants. In this case, a merger always entails a rationalization gain since the production is reallocated from a high-cost to a low-cost firm. [1] Despite this, the theoretical literature dealing with horizontal M&A assumes exogenous cost asymmetries and efficiency gains.[2]

The purpose of this paper is precisely to study how the strategic long-run decisions, such as cost-reducing R&D investments prior to the decision for integration, create endogenous cost asymmetries and cost efficiencies that make a merger profitable.

The issue of mergers between firms with asymmetric costs was firstly studied by Barros (1998). He argues that when a merger involves firms with cost differences, the efficiency gains from the reallocation of production towards the low-cost firm depend on the degree of asymmetry and how small the pre-merger output of the least efficient firm was. Barros (1998) finds that the efficiency gains of the merger are non-monotonic on the degree of asymmetry: For moderate cost asymmetries, the most profitable merger occurs among the less and the most efficient firms, because of the sizable output effect of the latter. For large asymmetries, the output-redistribution gains almost nil because the production of the less efficient firm is negligible. Straume (2003) studies how the efficiency gains from mergers between firms with cost asymmetries, jointly with

[1] Röller et al. (2001) distinguish between five categories of possible efficiencies that may arise from horizontal mergers: (1) rationalization of production, which refers to cost savings from reallocating production across firms, without increasing the joint technological capabilities; (2) economies of scale, i.e. savings in average costs associated with an increase in total output; (3) technological progress, which may stem from the diffusion of know-how or increased incentives for R&D; (4) purchasing economies or savings in factor prices such as intermediate goods or the cost of capital; (5) reduction of slack (managerial and X-efficiency).

[2] We know from the analysis of Salant et al. (1983) that in the absence of any cost efficiencies, only mergers that almost lead to a full-blown monopoly would be profitable. Perry and Porter (1985) introduced the cost efficiencies in the literature for horizontal M&A. They modeled the merger as the taking over of the tangible assets from the merging firms. However, the cost efficiencies in their model arise form the expansion of the merged entity's technological capabilities and potential output and not from the reallocation of production from the high-cost to the low-cost firm.

the use of strategic managerial delegation differentiate the private incentives for horizontal mergers from the social ones. Borek et al. (2003) analyze bilateral mergers between firms with cost asymmetries under two-sided asymmetric information about firms' marginal cost. In Amir et al. (2004) only the post-merger firm knows the exact value of its marginal cost and the corresponding cost efficiencies, while the outsider firms know the probabilities with which, the possible levels of the merged entity's marginal cost will occur. Their analysis gives rise to the informational market power of the merged entity, and their main result is that for the merger to be profitable, the outsiders must believe with a sufficiently high probability that the merged firm will experience a high enough efficiency gain.

Contrary to the bulk of the theoretical literature for horizontal M&A, where the cost asymmetries and the efficiency gains are assumed to be exogenous, this paper examines under which circumstances the cost-reducing R&D investments, prior to the decision for integration, induce endogenous cost asymmetries and efficiency gains that make a horizontal integration profitable.

We consider a three-firm Cournot oligopoly model with homogenous products, where each firm can invest in R&D for cost-reducing process innovations.[3] In order to examine how the R&D investments induce endogenous cost asymmetries that allow for efficiency gains, we consider a three-stage game. In the first stage, the firms invest in R&D, in the second stage they decide whether to integrate or not and in the third stage of the game, the firms compete in quantities. We also consider that the antitrust authority does not allow the integration to monopoly.

We distinguish between two different types of transaction for horizontal integration, that differ with respect to the split of the integrated entity's gross profits: Firstly, in the merger-type of transaction, the participating firms are exogenously engaged in the merger and there is commitment over an exogenous share of the merged entity's gross profits that each participant will receive. In addition to that, the one of the two participating firms abstains from investing in R&D in order to avoid the wasteful duplication of R&D effort. Secondly, in the acquisition-type of transaction there is no commitment. The bidder firm submits a 'take-it-or-leave-it' tender offer in order to acquire a designated target firm,

[3] Our main analysis is based on the assumption that the cost-reducing R&D investments of the firms are perfect research substitutes, implying that the firms follow similar research paths that lead with certainty to the same innovation (see e.g. Katsoulacos and Ulph, 1998). In an extension, we also examine the case of complementary research paths where the integrated entity produces its output by carrying out the innovations of its both constituent parts.

while the target firm invests in R&D strategically, so as to maximize the purchase price that it will receive from the bidder. The target firm's strategic behavior induces wasteful duplication of R&D efforts and reduces the profitability of the acquisition.

In both types of transaction, the efficiency gains for the integrated entity arise from the re-allocation of production towards the low-cost participant and the shutdown of the high-cost one. Subsequently, in our model, there are two contrasting effects on the integrated entity's profit: First, the integrated entity's profit is positively affected by the efficiency gains created by its rationalization of production and the elimination of the less-efficient firm from production and competition. Second, the shutdown of the high-cost participant implies higher market concentration. We know from the study by Salant et al. (1983) that in order to exploit the increased market power that follows from the merger, the merged entity raises the price and the outside firm responds by expanding its output. This "business stealing" effect tends to decrease the integrated entity's profit.

When the firms decide whether to integrate or not, the costs for the R&D investments have been sunk. Thus, each firm has incentives for integration only if the share of the integrated entity's gross profits that will receive exceeds the standing-alone profits that it can earn in case of no-integration, given the investments that the firms have already undertaken. For the case of merger, we find that the candidate merger participants have incentives for integration only if the share of profits that the participant that invests in R&D receives belongs to a specific parameter area. We also find that the higher the share of the merged entity's gross profits that the investing-firm receives, the higher that the effectiveness of the R&D investments on the reduction of the marginal cost must be. Considering the case of acquisition, we find that the bidder firm has incentives for integration, if the effectiveness of the R&D investments is sufficiently high. The target firm is found to be indifferent for the acquisition because the purchase price that it receives is equal to the profits that it would earn under no-acquisition, given the R&D investments that the firms have already undertaken. Interestingly,the minimum level of the effectiveness of R&D investments that guarantees the profitability of the acquisition is higher than the corresponding in case of merger.

We also apply our model for the case where the R&D investments of the firm are perfect research complements, implying that the integrated firm produces its output by carrying out the innovations of its both constituent parts. Our results are reversed with respect that the minimum level of the effectiveness of R&D investments that guarantees the profitability of the acquisition is lower than the corresponding in case of merger. It happens because in the present case, the overinvestment caused by the target firm's strategic behavior to increase its purchase price makes the post-acquisition entity's marginal cost to be lower than the corresponding of the post-merger entity.

Contrary to the theoretical literature where the horizontal mergers and the acquisitions are treated as identical, our analysis reveals that these two types of horizontal integration differ with respect to the strategic interactions and the equilibrium market outcomes that they induce.

Although there is a literature for the effects of M&A decisions on R&D investments, the questions addressed in the present paper differ from those addressed in the above line of research. Stenbacka (1991) along with Wong and Tse (1997) examine the bidder firm's incentives to reveal its cost realization to the target firm, prior to the takeover, depending on the spillover magnitude in the industry and the efficiency of the R&D technology. Canoy Riyanto and Van Cayseele (2000) study the impact of potential takeovers on the R&D investments that the managers undertake, depending on the distribution of bargaining power between the acquiring firm, the target manager, and shareholders of the target firm. Socorro (2004) argues that firms may strategically use R&D investments to signal their ability to fit well. Finally, Banal-Estañol et al. (2003) examine how the internal conflict among the managers of the merged entity affects the level of cost-reducing investments.[4]

The paper is organized as follows. In the next section, we present the model with a benchmark for comparisons. In Section 3, we investigate firms' incentives for a merger-type of integration, while in Section 4 we analyze how our results change in case of the acquisition. In Section 5, we conduct a welfare analysis, and in Section 6 we discuss some extensions of our model. We offer some concluding remarks in Section 7.

[4]There is also a scant empirical literature for the effects of R&D investments on the M&A decision. Blonigen and Taylor (2000), using a panel of 217 U.S. electronic and electrical equipment firms during 1985-1993, find a strong negative correlation between R&D intensity and acquisition activity. They mention that this correlation may occur because firms are choosing between an internal growth strategy with relatively high R&D intensity versus an external growth strategy with acquisitions. This is what is traditionally known as "make or buy" strategy. Dessyllas and Hughes (2005), using a dataset covering 9,744 acquisitions during the period 1984-2001, present findings in favor of the "make or buy" strategy as well. On the contrary, Lehto and Lehtoranta (2004), using data from Finland for the period 1994-1999, find that the high level of R&D, given the firm size, increases both the probability of becoming both the subject and the object of an acquisition.

## 2 Some preliminaries

### 2.1 The model

Consider an oligopoly industry that consists of three firms producing a homogenous product. Firm $i$ produces quantity $q_i$, with $i = 1, 2, 3$. In this industry, the inverse demand function is linear, given by $p = \alpha - Q$, where $p$ is price, $\alpha$ is a positive constant and $Q = \sum_{i=1}^{3} q_i$ is the total output. We assume that there is no entry or threat of entry in this industry. Competitors are considered to have the equal marginal cost $c$ ($c \leq \alpha$) and identical R&D technologies. Firm $i$ can invest in R&D for cost-reducing process innovations. Thus, the overall marginal cost for firm $i$ is given by $c - x_i$, where $x_i$ is the cost reduction due to R&D investment. Following d'Aspremont and Jacquemin (1988), the cost of R&D is assumed to be quadratic, having the form $\gamma x_i^2/2$ and reflecting the existence of diminishing returns to R&D expenditures. The parameter $\gamma$ represents the effectiveness of R&D investments. As $\gamma$ increases, the expenditure to obtain a given cost reduction also increases, implying that the effectiveness of a given amount invested in R&D decreases. The total cost function $C_i$ for firm $i$ is given by $C_i = (c - x_i)q_i + \gamma x_i^2/2$.

Firms maximize their profits with respect to three decision variables: The level of their R&D investments, whether to integrate or not, and the level of output. We assume that the antitrust authority would block the integration to monopoly and we allow firms 1 and 3 to be the candidate firms for integration. We formalize these decisions in the following three-stage game:

**Stage 1:** Firms invest in R&D.

**Stage 2:** Firms 1 and 3 decide whether to integrate or not.

$I_i$ is an indicator function that can take the values 0 or 1 as follows:

$$I_i = \begin{cases} 1 & \text{if firm } i \text{ integrates} \\ 0 & \text{if firm } i \text{ does not integrate} \end{cases}$$

**Stage 3:** Firms set quantities.

A key assumption of our model is that the cost-reducing R&D investments of the firms are perfect research substitutes and deterministic. Or else, firms follow similar research paths (duplicative research, see e.g. Katsoulacos and Ulph, 1998) that lead with certainty to the same innovation.

When firms 1 and 3 decide whether to integrate or not, the R&D costs have been sunk. Thus, the decision for integration is based upon their gross profits. Then, the integration can be reached through either the *merger*-type, or the *acquisition*-type of transaction. We consider that these two types differ with respect to the split of the integrated entity's gross profits: In the *merger*-type, the firms 1 and 3 are exogenously engaged in the merger and also, there is commitment over the exogenous share of the merged entity's gross profits that each participating firm will receive. This is identical to the "Fixed Profit Share" rule in the terminology of Borek et al. (2003). In the *acquisition*-type of transaction, the bidder firm submits a 'take-it-or-leave-it' tender offer in order to acquire the target firm. In the present case, the target firm behaves strategically in the R&D stage, so as to maximize the purchase price that it will receive from the bidder, rather than to commit over a predetermined share of profits.[5]

Regarding the integrated entity's technology, we follow the standard approach in the IO literature and assume that the above entity will produce all its output with the minimum of the marginal costs of its constituent parts: $c_I = min\{c_1, c_3\}$. The re-allocation of production towards the low-cost participant and the shutdown of the high-cost one are the precise sources of the efficiency gains that the integrated entity exploits.

We solve the above model by employing the Subgame Perfect Nash Equilibrium (SPNE) solution concept. To investigate the conditions under which a strategy (*to merge* or *not to merge* and *to acquire* or *not to acquire*) is an equilibrium, we proposing a candidate equilibrium configuration and then we examine whether it survives *all possible* strategy deviations.

## 2.2 A benchmark

We begin our analysis with the candidate equilibrium of *no-integration* ($N$) (*no-merger*, *no-acquisition*), as a benchmark for later comparison. In the third stage of the game, firms compete *a la Cournot* in a triopoly, so as to maximize their profits. Thus, given R&D investments and the *no-integration* decision, each firm $i$ sets output in order to maximize profits:

$$\Pi_i^N = (a - Q - c - x_i^N)q_i^N, \ i = 1, 2, 3 \tag{1}$$

[5]In our case, the "acquisition" is similar to the "endogenous merger", in the spirit that has been used by Gonzalez-Maestre and Lopez-Cunat (2001) and Ziss (2001) who examine the profitability of horizontal mergers under the delegation of output decisions. In their models, "a merger is endogenous if the target firms act strategically in the acquisition process by holding out for a buy-out price equal to the profits they would obtain if they were the only hold-out in a multi-firm merger (Kamien and Zang, 1990)."

The first-order-condition (foc) of eq. (1) provides firm $i$'s reaction function $R_i^N(q_{-i}^N) \equiv q_i^N = \frac{1}{2}(\alpha - c - q_{-i}^N + x_i^N)$, where $q_{-i}^N = \sum_{\forall j \neq i} q_j^N$ is the aggregate output of all the firms except $i$. Solving the system of the foc, the equilibrium firm-level output is:

$$q_i^N(x_i^N, x_{-i}^N) = \frac{1}{4}(\alpha - c + 3x_i^N - x_{-i}^N) \tag{2}$$

where $x_{-i}^N = \sum_{\forall j \neq i} x_j^N$ is the sum of competitors' R&D investments. Then, each firm's gross profits are $\pi_i^N(x_i^N, x_{-i}^N) = \left[q_i^N(x_i^N, x_{-i}^N)\right]^2$.

Having proposed the *no-integration* $(N)$ as a candidate equilibrium implies that in the second stage of the game, the indicator function $I_i$ takes the value $I_i = 0$, for $i = 1, 2, 3$.

In the first stage of the game, firms invest simultaneously in R&D so as to maximize profits:

$$\Pi_i^N = \left[\frac{1}{4}(\alpha - c + 3x_i^N - x_{-i}^N)\right]^2 - \frac{1}{2}\gamma(x_i^N)^2 \tag{3}$$

From the foc of the above equation, the reaction function for firm $i$ is $R_i^N(x_{-i}) \equiv x_i^N = 3\left(a - c - x_{-i}^N\right)/(8\gamma - 9)$. Note that $dx_i^N/dx_{-i}^N < 0$, i.e., R&D investments are strategic substitutes for the firms. Then, the equilibrium firm-level R&D investments are:

$$x_i^N = \frac{3\,(a-c)}{8\gamma - 3} \tag{4}$$

Substituting (4) into (3) yields firm-level output and profits:

$$q_i^N = \frac{2\gamma\,(a-c)}{8\gamma - 3} \qquad \Pi_i^N = \frac{(8\gamma^2 - 9\gamma)\,(a-c)^2}{2(3 - 8\gamma)^2} \tag{5}$$

with the subsequent industry-wide output, R&D investments and profits being $Q^N = \sum_{i=1}^{3} q_i^N$, $X^N = \sum_{i=1}^{3} x_i^N$ and $T\Pi^N = \sum_{i=1}^{3} \Pi_i^N$ respectively. The non-negativity constraint for R&D and output in equilibrium implies that $\gamma > \frac{3}{8}$. Furthermore, to avoid corner solutions, equation $\Pi_i^{NM} > 0$ requires that $\gamma > \frac{9}{8}$. The latter restriction will be imposed to the parameter $\gamma$.

## 3 The case of merger

Let us now examine the *merger* $(M)$, as a candidate equilibrium. The merged entity $(m)$ will produce with the minimum of the marginal costs of its constituent parts, implying that $c_m = min\{c_1, c_3\}$. This fact, jointly with the shut-down of the less efficient firm (we assume that the firm 3 is the one that will shut down), give rise to the realization of efficiency gains for the merger participants. Given R&D investments and the merger between firms 1 and 3, in the third stage of the game the merged entity ($m$) and the outsider firm 2 compete in a duopoly and set output so as to maximize their profits given by:

$$\Pi_i^M = (a - q_i^M - q_j^M)q_i^M - (c - x_i^M)q_i^M,\; i,\, j = m, 2,\; i \neq j \qquad (6)$$

The first-order-condition of the above equation provides firm $i$'s reaction function $R_i^M(q_{-i}^M) \equiv q_i^M = \frac{1}{2}(\alpha - c - q_j^M + x_i^M)$ and the solution of the system of focs provides the equilibrium firm-level output:

$$q_i^M\left(x_i^M, x_j^M\right) = \frac{1}{3}(\alpha - c + 2x_i^M - x_j^M) \qquad (7)$$

with the corresponding gross profits for each firm being $\pi_i^M(x_i^M, x_j^M) = \left[q_i^M\left(x_i^M, x_j^M\right)\right]^2$, $i,\, j = m, 2,\; i \neq j$.

Having proposed the *merger* ($M$) as a candidate equilibrium suggests that the second stage of the game is characterized by the following strategy vector: $(I_1, I_2, I_3) = (1, 0, 1)$. Given that R&D costs have been sunk, if the merger is to be formed, the participants commit over the distribution of the merged entity's gross profit ($\pi_m^M$), according to some predetermined and exogenous rule:

$$\pi_m^M(x_i^M, x_j^M) = \pi_1^M(x_i^M, x_j^M) + \pi_3^M(x_i^M, x_j^M) \qquad (8)$$

with $\pi_1^M(x_i^M, x_j^M) = \beta * \pi_m^M(x_i^M, x_j^M)$, $\pi_3^M(x_i^M, x_j^M) = (1-\beta) * \pi_m^M(x_i^M, x_j^M)$ and $\beta \in [0, 1]$ being common knowledge prior to the merger.

Let us now restrict our attention to the first stage of the game. Firm 3 anticipates that the merger with firm 1 imposes its own shutdown. In addition to that, as far as the research paths are duplicative and lead with certainty to the same innovation, the firm 3 abstains from investing in R&D. From the other side, the firm 1 undertakes the R&D investments and covers the merged entity's R&D cost, given the predetermined share $\beta$ of the merged entity's gross profits that it will receive.

As a result, in the first stage of the game, firms 1 and 2 invest in R&D so as to maximize their profits given by:

$$\Pi_1^M = \beta * \left[\frac{1}{3}(\alpha - c + 2x_m^M - x_2^M)\right]^2 - \frac{1}{2}\gamma(x_m^M)^2 \qquad (9)$$

$$\Pi_2^M = \left[\frac{1}{3}(\alpha - c + 2x_2^M - x_m^M)\right]^2 - \frac{1}{2}\gamma(x_2^M)^2 \qquad (10)$$

The reaction functions are $R_1^M(x_2^M) \equiv x_m^M = 4\beta\left(a-c-x_2^M\right)/(9\gamma-8\beta)$ and $R_2^M(x_m^M) \equiv x_2^M = 4\left(a-c-x_m^M\right)/(9\gamma-8)$ respectively. Solving the system of the foc, R&D investments are given by:

$$x_m^M = \frac{4\beta(3\gamma-4)(a-c)}{3\gamma(9\gamma-8)-8\beta(3\gamma-2)} \qquad x_2^M = \frac{4(4\beta-3\gamma)(a-c)}{3\gamma(8-9\gamma)-8\beta(3\gamma-2)} \tag{11}$$

In case of merger, the R&D investments vector is the following: $(x_1^M, x_2^M, x_3^M) = (x_m^M, x_2^M, 0)$. Substituting (11) into (7), (9) and (10) yields the following output and profits for firms $m$ and 2:

$$q_m^M = \frac{3\gamma(4-3\gamma)(a-c)}{3\gamma(8-9\gamma)+8\beta(3\gamma-2)} \qquad \Pi_m^M = \frac{(9\gamma-8\beta^2)(4-3\gamma)^2\gamma(a-c)^2}{[8\beta(3\gamma-2)-3\gamma(9\gamma-8)]^2} \tag{12}$$

$$q_2^M = \frac{3\gamma(4\beta-3\gamma)(a-c)}{3\gamma(8-9\gamma)+8\beta(3\gamma-2)} \qquad \Pi_2^M = \frac{(4\beta-3\gamma)^2\gamma(9\gamma-8)(a-c)^2}{[8\beta(3\gamma-2)-3\gamma(9\gamma-8)]^2} \tag{13}$$

with $Q^M = q_m^M + q_2^M$, $X^M = x_m^M + x_2^M$ and $T\Pi^M = \Pi_m^M + \Pi_2^M$. The non-negativity constraint for R&D, output and profits implies that $\gamma > \frac{4}{3}$. Comparing final good quantities and R&D investments in case of merger with the corresponding in case of no-merger, we have the following results:

**Lemma 1** *(i)* $q_m^M < 2q_i^N$, $q_2^M > q_i^N$, $q_2^M > q_m^M$, $Q^N > Q^M$.
*(ii)* $x_m^M < 2x_i^N$, $x_2^M > x_i^N$, $x_2^M > x_m^M$, $X^N > X^M$.

The intuition behind these results goes as follows:

The merger has two contrasting effects on the merged entity's output: From the one side, the merged entity's rationalization of production creates cost efficiencies that tend to increase output. From the other side, the elimination of the firm 3 implies a higher market concentration. In order to exploit the increased market power that follows from the merger, the merged entity raises the price and the outside firm responds by expanding its output. This "business stealing" effect tends to decrease the integrated entity's output.

Our analysis suggests that it is the "business stealing" effect that dominates and thus, the merged entity's output is lower than the combined, pre-merger production of its constituent firms ($q_m^M < 2q_i^N$). Given that final good quantities are strategic substitutes, the aforementioned externality that the merger induces, favors the outsider firm that expands its production, compared to the symmetric pre-merger output, with $q_2^M > q_i^N$.

According to the R&D investments effects of the merger, as far as firms 1 and 3 merge and avoid the duplication of R&D activities, the merged entity's R&D investments are lower than the combined, pre-merger investments of its constituent firms ($x_m^M < 2x_i^N$). From the other side, the merger leads to the increase of the firm 2's R&D investments ($x_2^M > x_i^N$). This expansion is caused by the externality that the merger induces in the output stage, according to which, the firm 2 anticipates that will expand its output and thus, it also increases its R&D investments.

When the firm 1 invests in R&D knows that it will receive only part $\beta$ of the merged entity's gross profits while covering the bulk of the R&D cost. As far as R&D investments are strategic substitutes, the outsider firm 2 invests more than the firm 1 does ($x_2^M > x_m^M$) which results in $q_2^M > q_m^M$. According the total R&D investments in the industry, the merger participants avoid the duplication of R&D activities and although the firm 2 increases its R&D investments, total R&D in case of merger is lower than the corresponding in case of no-merger $\left(X^N > X^M\right)$ and subsequently, $Q^N > Q^M$.

Having proposed both the *no-integration* and the *merger* as candidate equilibria, we are now ready to examine firms' incentives to merge.

Given $(x_m^M, x_2^M, 0)$, firm 1 and firm 3 have incentives to merge only if the share of the merged entity's gross profits that each merger participant receives is higher than the standing-alone profits $\pi_i^N(x_m^M, x_2^M, 0)$ that it would earn. Thus, for the merger to be formed, both of the following conditions must hold:

$$\text{Incentives for merger} \begin{cases} \pi_1^M(x_m^M, x_2^M) = \beta\pi_m^M(x_m^M, x_2^M) > \pi_1^N(x_m^M, x_2^M, 0) \\ \text{and} \\ \pi_3^M(x_m^M, x_2^M) = (1-\beta)\pi_m^M(x_m^M, x_2^M) > \pi_3^N(x_m^M, x_2^M, 0) \end{cases}$$

for firm 1 and firm 3 respectively. The later condition implies that the firm 3 has incentives for merger only if the compensation that it receives to stay out of the competition is higher than the standing-alone profits that it would earn in a triopoly, given that it would have not invested in R&D.

Applying the above criteria, allows us to state the following proposition.

**Proposition 2** *Firm 1 and firm 3 have incentives for merger only if*

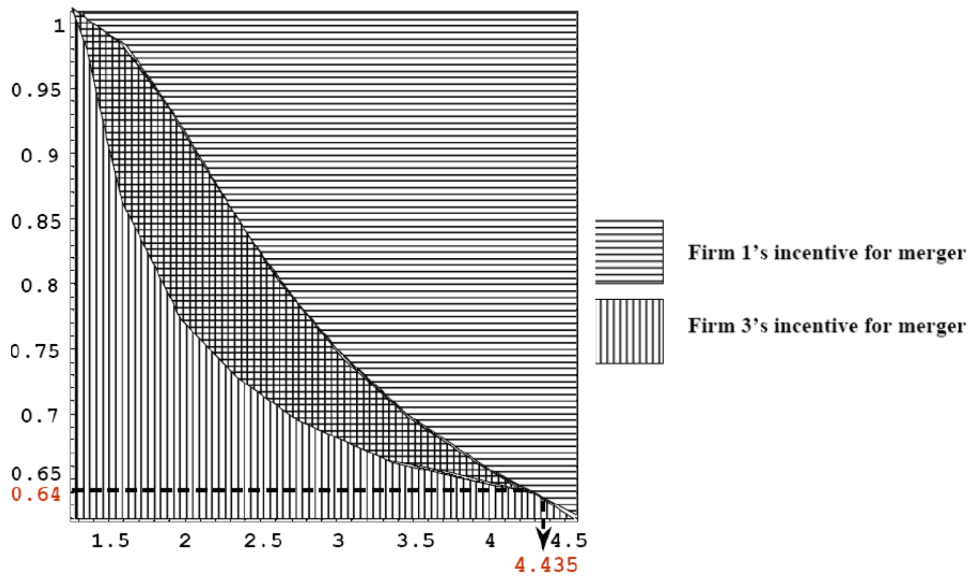


Figure 1: Firms' incentives for merger

$\widehat{\beta}_1(\gamma) \leq \beta \leq \widehat{\beta}_3(\gamma)$ *with* $\frac{d\widehat{\beta}(\gamma)}{d\gamma} < 0$, $\beta_{\min} = 0.64$ *and* $\beta_1(4/3) = \beta_3(4/3) = 1$.

For a proof of Proposition 1, see Appendix A. Fig. 1 represents a visualisation of the results in Proposition 1.

Intuitively, the profitability of the merger depends on two contradicted effects: The merged entity's profits are positively affected by the efficiency gains created by its rationalization of production and the elimination of the less-efficient firm from production and competition. From the other side, as the merged entity raises the price, in order to exploit the increased market power that follows from the merger, the outside firm responds by expanding its output. This "business stealing" effect tends to decrease the profit of the merged entity.

If the firm 1 anticipates that in the second stage of the game the merger with the firm 3 is to be formed, it invests $x_m^M$ given the commitment over the share ($\beta$) of the merged entity's gross profits $\pi_m^M(x_m^M, x_2^M)$ that it will receive. Thus, the firm 1 has incentives for merger only if it is to receive a share $\beta > \widehat{\beta}_1(\gamma)$ of the merged entity's gross profits. The relation $\frac{d\widehat{\beta}(\gamma)}{d\gamma} < 0$ implies that the higher the share of the merged entity's gross profits that firm 1 receives, the higher that the effectiveness of the R&D investments must be. $\beta_{\min} = 0.64$ suggests that the firm 1's minimum claim exceeds the half of the merged entity's gross profits. $\beta(4/3) = 1$ implies that for the firm 1 to receive all the merged entity's gross profits, the effectiveness of the R&D investments must be at the maximum.

According to the firm 3, the condition $(1-\beta)\pi_m^M(x_m^M, x_2^M) > \pi_3^N(x_m^M, x_2^M, 0)$ holds only if $\beta < \widehat{\beta}_3(\gamma)$. This finding suggests that the firm 3 has incentives for merger only if the share of the merged entity's gross profits that the firm 1 receives is sufficiently low. Given $(x_m^M, x_2^M, 0)$ the firm 3 would be the less efficient firm in the triopoly, with $\pi_1^N(x_m^M, x_2^M, 0) > \pi_2^N(x_m^M, x_2^M, 0) > \pi_3^N(x_m^M, x_2^M, 0)$. When both of the above conditions hold, $\pi_m^M(x_m^M, x_2^M) > \pi_1^N(x_m^M, x_2^M, 0) + \pi_3^N(x_m^M, x_2^M, 0)$ holds too.

Although $\Pi_2^M > \Pi_m^M$ is always true, implying that there is a free-rider problem, our results suggest that a merger takes place under the conditions of the Proposition 1 even if the outsider firm gains more than the insiders because given $(x_m^M, x_2^M, 0)$ the deviation to the *no-integration* equilibrium is not profitable for the candidate merger participants.

## 4 The case of acquisition

Let us now examine the *acquisition*-type of integration $(A)$, as a candidate equilibrium. Following Inderst and Wey (2004), we assume that there is a single exogenous target that is designated to be the firm 3. That is, we only consider one possible round of acquisition, and we specify which firm is the target. By assigning a predetermined role to each firm, we avoid the problem of multiple equilibria, that is a major complexity in merger models among asymmetric firms (see for instance Barros, 1998; Gowrisankaran, 1999; Straume 2003).

Thus, given R&D investments and the acquisition of the firm 3 from the firm 1, in the third stage of the game the post-acquisition entity $(a)$ and the outsider firm 2 set output so as to maximize their profits that are identical to the case of merger. In the same lines, the second stage of the game is characterized by the strategy vector $(I_1, I_2, I_3) = (1, 0, 1)$.

Let us now restrict our attention to the first stage of the game. We have already assumed that in the *acquisition*-type of integration, the target firm invests in R&D so as to maximize the compensation that it will receive in order the acquisition transaction to be held. Thus, in the first stage of the game, the three firms invest in R&D in order to maximize profits given by:

$$\Pi_1^A = \left[\frac{1}{3}(\alpha - c + 2x_1^A - x_3^A)\right]^2 - \frac{1}{2}\gamma(x_1^A)^2 - \left[\frac{1}{4}(\alpha - c - x_1 + 3x_2^A - x_3^A)\right]^2 \tag{14}$$

$$\Pi_2^A = \left[\frac{1}{3}(\alpha - c + 2x_2^A - x_3^A)\right]^2 - \frac{1}{2}\gamma(x_2^A) \tag{15}$$

$$\Pi_3^A = \left[\frac{1}{4}(\alpha - c - x_1^A + 3x_2^A - x_3^A)\right]^2 - \frac{1}{2}\gamma(x_3^A) \quad (16)$$

Observe that, the profits of the bidder firm $\left(\Pi_1^A\right)$ are the profits in a duopoly reduced by the acquisition price of the target firm 3. The later is equal to the gross profits that the target would earn in case of no-acquisition $\left(\Pi_3^N\right)$. The reaction functions are $R_1^A(x_2^A, x_3^A) \equiv x_1^A = [41\left(a - c - x_2^A\right) + 27x_3^A]/(72\gamma - 55)$, $R_2^A(x_1^A) \equiv x_2^A = 4\left(a - c - x_1^A\right)/(9\gamma - 8)$ and $R_3^A(x_1^A, x_2^A) \equiv x_3^A = 3\left(a - c - x_1^A - x_2^A\right)/(8\gamma - 9)$ respectively. Note that $dx_1^A/dx_3^A > 0$, i.e., R&D investments between the bidder firm and the target firm are strategic complements, while $dx_1^A/dx_2^A < 0$ implies that R&D investments between the bidder firm and the outsider firm are strategic substitutes.

Then, asymmetric firm-level R&D investments, output and profits are:

$$x_1^A = \frac{(41\gamma - 36)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)} \quad x_3^A = \frac{9(3\gamma - 4)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)} \quad (17)$$

$$x_2^A = \frac{(8\gamma - 9)(\alpha - c)}{18\gamma^2 - 26\gamma + 9} \quad (18)$$

$$q_a^A = \frac{3\gamma(4\gamma - 3)(\alpha - c)}{36\gamma^2 - 52\gamma + 18} \qquad q_2^A = \frac{3\gamma(8\gamma - 9)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)} \quad (19)$$

$$\Pi_1^A = \frac{(504\gamma^4 - 1681\gamma^3 + 2448\gamma^2 - 1296\gamma)(\alpha - c)^2}{32(18\gamma^2 - 26\gamma + 9)} \quad (20)$$

$$\Pi_3^A = \frac{(72\gamma^2 - 81\gamma)(4 - 3\gamma)^2(\alpha - c)^2}{32(18\gamma^2 - 26\gamma + 9)} \quad (21)$$

$$\Pi_2^A = \frac{(9\gamma^2 - 8\gamma)(9 - 8\gamma)^2(\alpha - c)^2}{16(18\gamma^2 - 26\gamma + 9)} \quad (22)$$

with $Q^A = q_a^A + q_2^A$, $X^A = x_1^A + x_2^A + x_3^A$ and $T\Pi^A = \Pi_a^A + \Pi_2^A$.The non-negativity constraint for R&D output and profits in equilibrium implies that $\gamma > \frac{4}{3}$. Comparing final good quantities and R&D investments in case of acquisition with the corresponding in case of no-acquisition (no-merger), we have the following results:

**Lemma 3** *(i)* $q_a^A < 2q_i^N$, $q_2^A > q_i^A$, $q_a^A > q_2^A$, $Q^N > Q^A$.
*(ii)* $x_1^A > x_2^A > x_3^A$, $X^A > X^N$.

The output effects $q_a^A < 2q_i^N$, $q_a^A > q_2^A$ and $Q^N > Q^A$ hold for reasons identical with those stated in the case of merger. According to the R&D effects of the acquisition, the target firm invests so as to maximize the acquisition price that will receive from the bidder, while the bidder invests so as to maximize its profits net from the acquisition price. Thus, the bidder's R&D investments increase in the target's investments, as $dx_1^A/dx_3^A > 0$ suggests. As far as $dx_1^A/dx_2^A < 0$, it is straightforward that $x_1^A > x_2^A$ and subsequently, the post-acquisition entity's output exceeds the outsider firm 2's output.

Contrary to the *merger*-type of integration, where the merger participants avoid the duplication of R&D efforts and $X^M < X^N$, in case of acquisition, it is the target's and the bidder's strategic behavior that induces wasteful duplication of R&D activities and overinvestment that leads to $X^A > X^M$.

Let us now examine whether firm 1 and firm 3 have incentives to integrate through an acquisition. Each candidate acquisition participant has incentives for an *acquisition*-type of integration only if the gross profits that it receives through the acquisition exceed the corresponding standing-alone profits that it would earn, given $(x_1^A, x_2^A, x_3^A)$. More formally, for an *acquisition*-type of integration, the following conditions must hold:

$$\text{Incentives for acquisition} \begin{cases} \pi_1^A(x_1^A, x_2^A, x_3^A) > \pi_1^N(x_1^A, x_2^A, x_3^A) \\ \text{and} \\ \pi_3^A(x_1^A, x_2^A, x_3^A) > \pi_3^N(x_1^A, x_2^A, x_3^A) \end{cases}$$

for firm 1 and firm 3 respectively. Applying these criteria, we state the following proposition.

**Proposition 4** *Firm 1 and firm 3 have incentives for acquisition only if* $\gamma < 3.666$*.*

For a proof of Proposition 2, see Appendix B. The intuition behind this result goes as follows. The profitability of the *acquisition*-type of integration is affected positively by the cost efficiencies that the bidder's R&D investments create and negatively by the increased concentration in the post acquisition market structure. Our analysis suggests that for the cost-efficiencies effect to dominate the concentration effect, the effectiveness of the R&D investments must be sufficiently high, i.e. $\gamma < 3.666$. We also find that the compensation that the target firm receives to stay out of the competition is equal to the amount of the standing-alone gross profits that it would earn in a triopoly, given $x_1^A, x_2^A, x_3^A$. This fact makes the target to be indifferent for the acquisition.

Note that the minimum level of the effectiveness of R&D investments that guarantees the profitability of the acquisition ($\gamma_A = 3.666$) is higher than the corresponding in case of merger ($\gamma_M = 4.435$). In case of merger there is commitment over the distribution of the merged entity's gross profits among the owners of the formerly separate firms and merger participants avoid the duplication of R&D activities. In contrast to that, in the *acquisition*-type of transaction the target firm invests in R&D so as to maximize its purchase price, rather than to commit over a predetermined purchase price. Thus, it is the strategic behavior of the target firm that makes the acquisition transaction costly and demands the effectiveness of the R&D investments to be higher than the corresponding in the case of merger.

According to the free-riding externality of the acquisition, although $\Pi_2^A > \Pi_1^A$ (except if $\gamma < 1.941$), the acquisition takes place if $\gamma < 3.666$ because given $(x_1^A, x_2^A, x_3^A)$, the deviation to the *no-integration* equilibrium is not profitable for the candidate acquisition participants.

## 5 Welfare analysis

Competition authorities are concerned with horizontal M&A because of the potential price increase and the dead-weight loss, due to sub-optimal production and consumption that they cause. In the present part of the paper, following the influential contribution of Williamson (1968), we account for the net effects of the firms' integration on the social welfare. Thus, we assume that there exists a regulator who approves the merger or the acquisition only if it enhances total welfare. Total welfare is defined here as:

$$TW^I = T\Pi^I + CS^I, \; I = N, \; M, \; A \tag{23}$$

with $T\Pi^I$ and $CS^I = \frac{1}{2}\left(Q^I\right)^2$ corresponding to the overall industry profits and consumers' surplus respectively.

Using results in equilibrium from the previous sections, total welfare for each case is as follows:

$$TW^N = \frac{\left(60\gamma^2 - 27\gamma\right)(a-c)^2}{2\left(3-8\gamma\right)^2} \tag{24}$$

$$TW^M = \frac{4\gamma[12\beta\gamma(7-9\gamma) - 2\beta^2\left(9\gamma^2 - 51\gamma + 32\right) + \left(81\gamma^3 - 126\gamma^2 + 36\gamma\right)](a-c)^2}{32\left(18\gamma^2 - 26\gamma + 9\right)^2} \tag{25}$$

$$TW^A = \frac{\left(4608\gamma^4 - 11345\gamma^3 + 9387\gamma^2 - 2592\gamma\right)(a-c)^2}{32\left(18\gamma^2 - 26\gamma + 9\right)^2} \tag{26}$$

In order to answer the question, whether the antitrust authority approves the merger (acquisition), we compare the total welfare under each type of integration, with the corresponding in case of no-integration. We summarize our findings in the following proposition:

**Proposition 5** *(i) The antitrust authority approves the merger if* $\gamma < \widehat{\gamma}(\beta)$ *with* $\frac{d\widehat{\gamma}(\beta)}{d\beta} > 0$ , $\widehat{\gamma}(0) = 2.144$ *and* $\widehat{\gamma}(1) = 3.124$.

*(ii) The antitrust authority approves the acquisition if* $\gamma < 2.876$.

Let us now proceed to explain how we came to these results. Firms' integration has two contrasting effects on total welfare. The rationalization of the merged entity's production creates cost efficiencies that tend to increase overall industry profits and consumers' surplus. From the other side, the horizontal integration increases the market concentration, implying a higher price, which increases overall industry profits and reduces consumers' surplus. Thus, the net effect of the integration is ambitious.

Our analysis reveals that for the cost efficiencies, generated by the horizontal integration, to exceed the dead-weight loss, caused by its anti-competitive effects, the effectiveness of the R&D technology must be sufficiently high. Not surprisingly, the effectiveness of the R&D investments that guarantees a welfare-enhancing horizontal integration (merger, acquisition) is higher than the corresponding, ensuring that the same type of integration is profitable. This finding implies the contradiction between private and social incentives for horizontal integration. Especially for the merger-type of integration, the relation $\frac{d\widehat{\gamma}(\beta)}{d\beta} > 0$ suggests that the higher the share of the merged entity's gross profits that firm 1 receives, the lower that the effectiveness of the R&D investments needs to be, in order for the merger to be welfare-enhancing.

By assessing the welfare effects of the integration through the total welfare standard, the antitrust authority approves even mergers that lead to higher price, if the gains realized by producers exceed the losses experienced by consumers. In consequence, the total welfare standard does not examine whether the integration's efficiencies pass to consumers. The antitrust authority can investigate the above objective if it assesses the integration's welfare effects through the consumers' surplus standard. Our analysis reveals that $CS^M < CS^N$ and $CS^A < CS^N$ always hold, implying that in both types of horizontal integration, there is no efficiencies' pass-on to consumers. This finding also implies that the welfare enhancement in case of integration comes from the increase on the overall industry profits due to the higher market concentration.

## 6 Extensions and general discussion

In this part of the paper, we consider a modification of the basic model and we make a general discussion of our results.

### 6.1 The case of complementary research paths

Our previous analysis was grounded on the assumption that the R&D investments of the firms are perfect substitutes. Thus, the integrated entity exploited the cost efficiencies that raised from the re-allocation of production to the participant with the lower marginal cost and the shutdown of the other. Following Katsoulacos and Ulph (1998), we can also consider that the R&D investments of the firms are perfect research complements. In this case, the integrated firm (merged entity, post-acquisition entity) produces its output by carrying out the innovations of its both constituent parts, implying $c_I = c - x_1 - x_3$.

The above assumption implies that for the merger-type of integration both participating firms invest in R&D because both firms' R&D investments contribute equally to the merged entity's technology. Given their equal contribution, it is straightforward that $x_1^M = x_2^M$ and that the merged entity's gross profits are symmetrically shared among participants ($\beta = \frac{1}{2}$). According to the acquisition-type of integration, the overinvestment in R&D, induced by the target firm's strategic behavior, has two contrasting effects on the integrated entity's profits: It increases the target's purchase price, decreasing the integrated entity's profits, but it also contributes to the integrated entity's profits through the reduction of the marginal cost under which the above entity operates.

Applying the criteria for merger and acquisition incentives, we state our results in the following proposition:

**Proposition 6** *(i)Firm 1 and firm 3 have incentives for merger (acquisition) if* $\gamma < 7.771$ ($\gamma < 15.659$).

*(ii) The antitrust authority approves the merger (acquisition) if* $\gamma < 5.201$ ($\gamma < 9.938$).

The intuition behind these results goes similarly to the case of substitutable research paths. As expected, the effectiveness of R&D investments that guarantees a profitable and welfare enhancing integration (merger, acquisition), is lower than the corresponding in case of substitutable paths due to the synergistic gains that the complementary research paths create.

Contrary to the case of substitutable research paths, the minimum level of the effectiveness of R&D investments that guarantees the profitability of the acquisition is lower than the corresponding in case of merger. It happens because in the present case, the overinvestment in R&D, caused by the target firm's strategic behavior in order to maximize its purchase price, makes the post-acquisition entity's marginal cost to be lower than the corresponding for the post-merger entity.

Most of the effects stated in Lemmas 1 and 2 hold for the case of complementary paths as well. The only exception is the total output in case of acquisition. We find that $Q^A > Q^N$, and subsequenly $CS^A > CS^N$, if $\gamma < 2.5$. This finding suggests that the contribution of the target firm's R&D investments, to the post-acquisition entity's marginal cost, makes the positive effect of the cost-efficiencies effect on output to dominate the negative effects of increased market concentration, only if the effectiveness of R&D investments is sufficiently high.

## 6.2 A merger vs an acquisition

In this part of the paper we compare the equilibrium outcomes for the case of merger with the corresponding in case of acquisition under substitutable research paths, as far as the main body of our analysis was based on this assumption.

We prove that mergers and acquisitions differ with respect to the incentives behind them and their equilibrium outcomes. A first key difference between the merger and the acquisition relates to the R&D investments. Interestingly, we find that $X_a^A > X_m^M$. In the acquisition case, it is the strategic behavior of the target firm that increases the R&D investments of the bidder, while in case of merger; the participants avoid the duplication of R&D activities.

Given that R&D investments are strategic substitutes between competitors, it is straightforward that the outsider firm in case of merger invests more that the outsider firm in case of acquisition $\left(X_a^A < X_m^M\right)$. The wasteful duplication in R&D in case of acquisition and the avoidance of duplication of effort in case of merger, lead to $X^A > X^M$. Similar inequalities hold for firm-level and industry-wide output.

Concentrating on equilibrium profits, we find that the post-acquisition entity's profits exceed the corresponding of the merged entity's if the effectiveness of R&D investments is sufficiently high, i.e. $\gamma < \widehat{\gamma}(\beta)$, $\frac{d\widehat{\gamma}(\beta)}{d\beta} < 0$, $\gamma(0) = 2.42$ and $\gamma(1) = 1.62$. It is the target firm's strategic behavior in the case of acquisition that increases the cost of the transaction and reduces the profits of the post-acquisition entity. As far as $X_a^A < X_m^M$, the outsider firm's profits in case of merger $\left(\Pi_2^M\right)$ are higher than the corresponding in the acquisition-type of integration $\left(\Pi_2^A\right)$. We also find that industry-wide profits in case of merger are higher than the corresponding in case acquisition $\left(T\Pi^M > T\Pi^A\right)$. Finally, total welfare in case of merger exceeds the corresponding in case of acquisition if $\beta >$

$\widehat{\beta}(\gamma) = \frac{1}{32}(23 + \frac{27\gamma+24}{24+\gamma(36\gamma-61)})$, with $\frac{d\widehat{\beta}(\gamma)}{d\gamma} < 0$, $\beta(\frac{4}{3}) = 1$ and $\lim_{\gamma \to +\infty} \beta = 0.718$.

### 6.3 Bargaining over the sharing of profits

In the previous analysis, we assumed that the merger participants' R&D investments were driven by the commitment over the distribution of the merged entity's gross profits, according to an exogenous rule. For the acquisition-type of integration we assumed that the target firm invests in R&D so as to maximize the compensation that it will receive from the bidder firm.

However, Borek et al. (2003) mention that the profit that each firm receives through the integration can be considered as the outcome of a complex bargaining process that precedes the integration's decision. We do believe that it is the Generalized Nash Bargaining solution that captures the essential features of the underlying bargaining process. It also links the literature for M&A with the literature for non-cooperative bargaining (e.g., Binmore et al. 1986). In this case, the candidate firms for integration would invest in R&D strategically, so as each firm to increase its outside option (standing-alone profits in case of disagreement for integration) and strengthen its bargaining position during negotiations.

Indeed, the introduction of the Generalized Nash Bargaining solution in the M&A literature is itself an important motivation for our future research that also points out some important testable implications.

## 7 Concluding remarks

Contrary to the theoretical literature for horizontal M&A where the efficiency gains are assumed to be exogenous, this paper examines the circumstances under which, long-run strategic decisions in cost-reducing R&D investments, prior to the decision for integration, induce endogenous cost asymmetries and efficiency gains that make a horizontal integration profitable. In particular, we show that firms' incentives for horizontal M&A depend on the distribution of the integrated entity's profits and on the magnitude of the efficiency gains that the participants exploit.

Our analysis reveals that mergers and acquisitions, as two types of horizontal integration, differ with respect to the strategic interactions and the equilibrium market outcomes that they induce. Our model also leads to a number of testable implications for the profitability of horizontal M&A. Firstly, the profitability of the horizontal integration is positively related to the magnitude of the cost efficiencies that it exploits. Secondly, the profitability of the horizontal integration also depends on whether the cost efficiencies arise from ex-ante substitute or complementary technologies. Thirdly, the share of the integrated entity's profits that each participant receives is positively related to its efficiency.

Finally, as for a challenge for future research, we leave the more general case where the profit that each integration-participant receives is the outcome of a complex bargaining process that precedes the integration's decision.

## Appendix

### A. Proof of Proposition 1

Given $x_m^M$ and $x_2^M$ from eq. (11) and that $x_3^M = 0$, the firm 1 receives a share $\beta$ of the merged entity's gross profits $\pi_m^M(x_m^M,\ x_2^M) = \left[q_m^M\left(x_m^M,\ x_2^M\right)\right]^2$. Thus, the firm 1 receives

$$\pi_1^M(x_m^M, x_2^M, 0) = \frac{(9\gamma - 8\beta^2)\,(4-3\gamma)^2\,\gamma\,(a-c)^2}{[8\beta(3\gamma-2) - 3\gamma(9\gamma-8)]^2} \tag{A1}$$

Given the above R&D investments, if the firm 1 deviates form the *merger* equilibrium, the standing-alone gross profits that it earns, are given by $\pi_3^N(x_m^M,\ x_2^M, 0) = \left[q_3^N(x_m^M, x_2^M, 0)\right]^2$. Thus, firm 1 receives

$$\pi_1^N(x_m^M, x_2^M, 0) = \frac{(4-3\gamma)^2\,(4\beta+9\gamma)^2\,(a-c)^2}{16[3\gamma(8-9\gamma) + 8\beta(3\gamma-2)]^2} \tag{A2}$$

The firm 1 has incentives for merger as long as $\pi_1^M > \pi_1^N$, a condition that holds $\beta > \beta_1(\gamma) = \frac{9}{4}(2\gamma^2 - \gamma - 2\sqrt{\gamma^4 - \gamma^3})$. Q.E.D.

In the same lines, the firm 3 receives a share $(1-\beta)\ \pi_m^M(x_m^M,\ x_2^M) = (1-\beta)\left[q_m^M\left(x_m^M,\ x_2^M\right)\right]^2$. Thus, the firm 3 receives

$$\pi_3^M(x_m^M, x_2^M, 0) = \frac{9(1-\beta)\gamma^2\,(4-3\gamma)^2\,(a-c)^2}{[8\beta(3\gamma-2) - 3\gamma(9\gamma-8)]^2} \tag{A3}$$

In case of deviating from the *merger* equilibrium, the corresponding standing-alone gross profits that the firm 3 earns, are

$$\pi_3^N(x_m^M, x_2^M, 0) = \frac{9\,(4-3\gamma)^2\,(4\beta-3\gamma)^2\,(a-c)^2}{16[3\gamma(8-9\gamma) + 8\beta(3\gamma-2)]^2} \tag{A4}$$

The firm 3 has incentives for merger as long as $\pi_3^M > \pi_3^N$, a condition that holds if $\beta \leq \beta_3(\gamma) = \frac{1}{4}(3\gamma - 2\gamma^2 + 2\sqrt{4\gamma^2 - 3\gamma^3 + \gamma^4})$. Q.E.D.

## B. Proof of Proposition 2

Given $x_1^A$, $x_2^A$ and $x_3^A$ from eq. (17) and (18), the gross profits that the bidder firm receives in case of acquisition are

$$\pi_1^A(x_1^A, x_2^A, x_3^A) = \frac{63\gamma^2(\gamma^2 - 1)(\alpha - c)^2}{4\,(18\gamma^2 - 26\gamma + 9)} \tag{B1}$$

If the firm 1 deviates form the *acquisition* equilibrium, its corresponding standing-alone gross profits will be

$$\pi_1^N(x_1^A, x_2^A, x_3^A) = \frac{(5 - 9\gamma)^2\gamma^2\,(a - c)^2}{4\,(18\gamma^2 - 26\gamma + 9)} \tag{B2}$$

The firm 1 has incentives to bid for the firm 3 only if $\pi_1^A > \pi_1^N$, a

condition that holds if $\gamma < 3.666$. Q.E.D.

In the same lines, the gross profits that the target firms receives in case of acquisition are

$$\pi_3^A(x_1^A, x_2^A, x_3^A) = \frac{9(4 - 3\gamma)^2(\alpha - c)^2}{4\,(18\gamma^2 - 26\gamma + 9)} \tag{B3}$$

and its corresponding standing-alone gross profits in case of deviation from the *acquisition* equilibrium are

$$\pi_3^N(x_1^A, x_2^A, x_3^A) = \frac{9(4 - 3\gamma)^2(\alpha - c)^2}{4\,(18\gamma^2 - 26\gamma + 9)} \tag{B4}$$

Observe that $\pi_3^A(x_1^A, x_2^A, x_3^A) = \pi_3^N(x_1^A, x_2^A, x_3^A)$ suggesting that the target firm is compensated to stay out of the competition, with the exact amount of the gross profits that it would earn in a triopoly, given $x_1^A, x_2^A, x_3^A$.

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