DEPARTMENT OF ECONOMICS
UNIVERSITY OF CRETE

BE.NE.TeC. Working Paper Series

Working Paper: 2008-17

Horizontal Mergers and Acquisitions with Endogenous Efficiency Gains

Christos Cabolis, Constantine Manasakis, Emmanuel Petrakis

Business Economics & NEw TeChnologies Laboratory

www.soc.uoc.gr/benetec

Horizontal Mergers and Acquisitions with Endogenous Efficiency Gains*

Christos Cabolis† Constantine Manasakis‡ Emmanuel Petrakis§

June 2008

Abstract

We examine how the strategic long-run decisions, such as cost-reducing R&D investments, prior to the decision for integration; create endogenous efficiency gains that make a horizontal integration profitable. The "merger" and the "acquisition" are distinguished as different modes of horizontal integration, with respect to both incentives and equilibrium outcomes. We show that firms' incentives for integration depend on the magnitude of the cost efficiencies that R&D investments give rise to and the rule of sharing of the integrated entity's profits across participants. The welfare effects of horizontal integrations are also discussed.

Keywords Horizontal mergers and acquisitions; Processes Innovations; Endogenous efficiency gains.

JEL Classification C72; G34; O31

---

*We have benefited from comments and suggestions made during the presentations of earlier versions of this paper at the 4th Conference on Research on Economic Theory and Econometrics (CRETE 2005) at Syros, the 32nd Conference of the European Association for Research in Industrial Economics (EARIE 2005) at Porto, the XXI Jornadas de Economia Industrial (JEI 2005) at Bilbao, the Departmental Seminar Series of the Economics Department, University of Macedonia. Special thanks to John Geanakoplos for very valuable comments and suggestions. Full responsibility for all shortcomings is, of course, ours.

†ALBA Graduate Business School; e-mail: ccabolis@alba.edu.gr.

‡Department of Economics, University of Crete; e-mail: manasakis@stud.soc.uoc.gr.

§Corresponding author. Department of Economics, University of Crete, Univ. Campus at Gallos, Rethymnon 74100, Greece, Tel: +302831077407, Fax: +302831077406; e-mail: petrakis@ermis.soc.uoc.gr.

1 Introduction

Mergers and acquisitions (M&As) have been extensively used by firms as vehicles for growth and competitiveness within the context of the global economy (U.N., 2000; U.N., 2007). Restricting attention to horizontal M&A, Gugler et al. (2003) identify that over the period 1981-1998, nearly 16,500 were realized around the world (with each deal's worth being over $1 million), where profits increased by attaining efficiency gains. The question that easily arises is, where do these efficiency gains arise from?

This paper explores how do pre-integration long-run decisions create endogenous efficiency gains that result in profitable horizontal M&As; and what are the welfare effects of these M&As. In particular, it attempts to address the following three questions.

First, how do the pre-integration investments in cost-reducing R&D create endogenous efficiency gains? This question is motivated, on the one hand, by the variety of the sources of efficiency gains addressed in the literature and the scant empirical evidence regarding these sources (for a survey see Röller et al., 2001), on the other hand. Straume (2006) argues that the available evidence suggests that "the most commonly indicated among these sources is the presence of pre-integration cost asymmetries". This implies that the integration entails the reallocation of production, from the plants with the relatively high marginal costs to those with the relatively low, without increasing the joint technological capabilities. However, in the bulk of the relevant literature, the pre-integration cost asymmetries are assumed to be exogenous.[1] The purpose of this paper is precisely to study how firms invest strategically in cost-reducing R&D, prior to the decision for integration, so as to establish endogenous cost asymmetries and exploit efficiency gains.

Second, how does the method of payment through which the integration is realized affect the firms' R&D investments and integration incentives? Empirical evidence suggests a great variety on the methods of payment in M&As (see Faccio and Masulis, 2005 and the references therein). On the other hand, recent advances in modelling the integration process are divided in two strands. The first one restricts attention on "the limits of monopolization" through non-

[1] In another line of research, the efficiency gains are realized by the taking over of the merging firms' tangible assets. This makes the integrated firm to be larger than the pre-integration firms, by expanding its technological capabilities and reducing its marginal cost even below that of the more efficient participant's (Perry and Porter, 1985; Farrell and Shapiro, 1990; Motta and Vasconcelos, 2005).

cooperative acquisition transactions where each firm posts bids for the other firms and commits to a purchase price for its own (Kamien and Zang, 1990; Ziss, 2001; Gonzàlez-Maestre and López-Cuñat, 2001; Inderst and Wey, 2005). The second one, the *endogenous mergers* strand, focuses on "whether a particular market structure can be the outcome of a merger process" (Banal-Estañol et al., 2008). In particular, it compares all the possible mergers in order to find the equilibrium one (Barros, 1998; Horn and Persson, 2001; Lommerud et al., 2006; Straume, 2006).[2] Besides Barros (1998), this latter strand focuses on the equilibrium post-merger firm's profits while their *sharing* across participants, although crucial, is not explored. Our contribution is to point out that it is precisely the rule of sharing of the integrated firm's profits across participants that determines the firms' R&D investments and integration incentives.

Third, do the efficiency gains exploited by integration paricipants create any wealth gains for consumers? Moreover, should these efficiency gains be incorporated in the merger control? These question are crucial and have been motivated by the ongoing debate regarding the policy goals of merger control (Neven and Röller, 2005). On the one hand, Williamson (1968) along with Farrell and Shapiro (1990) argue that competition authorities should assess M&As on the basis of total welfare, implying that they should be allowed, even if their effect on consumers alone is negative. On the contrary, the US Department of Justice Merger Guidelines and the European Merger Guidelines assess M&As on the basis of their effects on consumers surplus.[3]

To address the above questions, we consider a three-firm Cournot oligopoly industry with homogenous products and initially symmetric marginal costs across competitors. The timing of moves is as follows. In stage one, firms invest in perfectly substitutable cost-reducing R&D activities. In the second stage, they decide whether to integrate or not, under the constraint that the antitrust authority does not allow a monopoly to be formed. At the final stage, firms compete in quantities.

[2] This is in contrast to the *exogenous merger* literature, in the taxonomy of Banal-Estañol et al. (2008). Whithin this literature, there is only one candidate merger and each firm in the industry is assigned a role that can not be changed (participant, no-paricipant). This implies the merger participants are exogenously given. Moreover, the merger is realized if and only if it increases each participant's profits, compared to those obtained in the no-merger scenario (Salant et al., 1983; Deneckere and Davidson, 1985; Perry and Porter, 1985; Farrell and Shapiro, 1990; Lommerud and Sørgard, 1997; Lommerud et al., 2005; Davidson and Ferrett, 2007).

[3] See U.S. Horizontal Merger Guidelines (1997, Section 4) and E.C. Horizontal Merger Guidelines (2004/03, art. 77) respectively.

We formalize two different types through which the integration can be formed, depending on the rule of sharing of the integrated firm's profits across participants: in the *acquisition*-type, the bidder firm, by paying a purchase price, acquires the target firm. This type of integration captures the stylized facts reported by Cramton (1998) according to which, target firms employ several tactics so as to maximize the purchase price to receive. In the present paper, the target firm invests in R&D so as to maximize its purchase price, but this induces wasteful duplication of R&D activities. In the *merger*-type instead, participants share the integrated firm's profits based on a pre-merger exogenously determined rule, while one of them abstains from investing in R&D and avoids the wasteful duplication of R&D activities. The type of integration is assumed to be exogenously given. The above formalization implies that although firms are initially symmetric, they do not invest equal amounts in R&D, ending up with asymmetric marginal costs.

Then, if the integration takes place, regardless of the type chosen, the integrated entity produces all its output with the minimum of the marginal costs of its constituent parts while the less efficient one shuts down (Barros, 1998; Straume, 2006). It is precisely this reallocation of production that induces the efficiency gains for the integrated entity. On the other hand, the post-integration higher concentration in the output market implies a relatively higher market share and price for the firm that does not participate in the integration. This is the "business stealing" effect outlined by Stigler (1950) and Salant et al., (1983) which negatively affects the profits of the integrated firm.

In this environment, we propose a candidate equilibrium configuration, assigning a special role to each firm. Then, we check whether, or not, it survives all possible deviations, in roles and configurations. This means that, given the R&D investments, all firms are allowed to choose whether to integrate and with whom.

In the acquisition-type of integration, the bidder's R&D investments increase in the target's investments so as the former to maximize its post-acquisition profits, net from the purchase price. The target firm's R&D investments induces wasteful duplication of R&D activities and increases the cost of the integration. Yet, the post-acquisition firm's profits are further decreased by the business stealing effect. On the contrary, the aforementioned profits are positively affected by the efficiency gains through the rationalization of production. We find that for the rationalization of production effect to dominate both the wasteful duplication of R&D and the business stealing effects, the R&D investments must be sufficiently effective in the reduction of the marginal cost. Moreover, in the unique stable acquisition, the most efficient firm in the industry acquires the least efficient one. This happens for two reasons. Firstly, because of the business stealing effect, the firm that has been assigned to be the outsider has no incentives to deviate towards becoming either the bidder or the target. Secondly, the proposed bidder's R&D investments are so high that its purchase price is not affordable by any firm.

In the merger-type of integration, there is no wasteful duplication of R&D activities, since one of the merger participants abstains from investing in R&D. This implies that the stable merger requires a relatively less effective R&D than the stable acquisition. We find that two firms have incentives for merger, if the one that invests in R&D receives a sufficiently high share of the post-merger profits, while the firm that abstains from investing is effectively compensated to shut down. Note that the only stable merger is formed between the two least efficient firms in the industry, contrary to the acquisition. Intuitively, the firm that has been assigned to be the outsider, in the candidate equilibrium configuration, has no incentives to deviate towards participating in any merger configuration, due to the business stealing effect.

Interestingly, the welfare effects of horizontal integrations depend crucially on the type of integration chosen and the effectiveness of the R&D investments that determines the magnitude of the efficiency gains. We find a significant contradiction between private and social incentives for horizontal integrations in the sense that the effectiveness of the R&D investments that guarantees a welfare-enhancing integration, under both types, is higher than that required for private profit-enhancing. Moreover, the respective effectiveness that guarantees a welfare-enhancing acquisition is higher than that for a welfare-enhancing merger. The latter underlines the dead-weight loss caused by the target firm's strategic behavior in the acquisition, that increases the integration's cost. We also find that whenever a horizontal integration increases total welfare, it is because of the increased industry profits. Therefore, from a competition policy perspective, we argue that policy measures for the assessment of horizontal integrations should carefully be designed, taking into account the relative efficiency of the participating firms and the transaction through which the integration will take place.

Our paper contributes to the literature on horizontal M&As with efficiency gains. Similarly to us, a recent branch of this literature has focused on endogenous mergers with efficiency gains arising from cost asymmetries across participants. In particular, Barros (1998) and Straume (2006) demonstrate that the number of equilibrium mergers and the identity of each equilibrium's participants depend on the level of cost asymmetry among firms. For moderate cost asymmetries, they find that the equilibrium merger occurs among the least and the most efficient firm. If instead the cost asymmetries are large, Barros (1998) finds that the merger takes place between the two most efficient firms, while in Straume (2006), the merger occurs among either the less and the most efficient firm or the two least efficient firms. Besides the problem of multiple equilibria present in these papers, they do not explore how did the cost asymmetries arise. Undertaking this task in the present paper, we demonstrate that it is precisely the pre-integration decisions and the sharing of the integrated firm's profits across participants that leads to endogenous cost asymmetries and efficiency gains where a unique stable integration is formed.

Our paper also contributes to the literature for the effects of M&As decisions on R&D investments. A number of papers within this literature deals with the R&D investments problem of firms in the prospect of horizontal M&As (Stenbacka, 1991; Wong and Tse, 1997; Canoy et al., 2000; Socorro, 2004). However, they restrict attention to R&D incentives solely. In the present paper instead, we broaden the analysis and explore the endogenous efficiency gains, the relative efficiency of the integration's participants and the integration's welfare effects.

The rest of the paper is organized as follows. In the next section, we present the model. In Section 3 we study the case of no-integration, as a candidate equilibrium. In Section 4, we investigate firms' incentives for the acquisition-type of integration, while in Section 5 we analyze incentives for the merger-type of integration. In Section 6, we conduct a welfare analysis. In Section 7, we compare the equilibrium outcomes under the two types of integration. Finally, Section 8 concludes.

2 The model

We consider a homogenous good industry where three firms compete in quantities. The inverse demand function for the final good is given by $P(Q) = a - Q$, where $Q = \sum_{i=1}^{3} q_i$ is the aggregate output. Firms are endowed with constant returns to scale technologies with their marginal cost being initially symmetric and equal to c ($c \leq a$). Firm i, by investing $\gamma x_i^2/2$ in R&D activities, can decrease its initial marginal cost by x_i. The total cost function for firm i is $C_i(.) = (c - x_i)q_i + \gamma x_i^2/2$.[4] The parameter γ represents the effectiveness of R&D investments on the reduction of the marginal cost. A higher γ denotes a less effective R&D, *ceteris paribus*. Equivalently, the higher the γ, the higher the required expenditure to obtain a given cost reduction, *ceteris paribus*.

Thus, firm i's net (from the R&D expenses) profits, are given by:

$$\Pi_i = (a - Q)q_i - (c - x_i)q_i - \gamma x_i^2/2 \tag{1}$$

We consider the following three-stage game. In the first stage, firms decide simultaneously their R&D investments. We assume that the outcome of the R&D is deterministic and perfectly substitutable between firms. This is similar to the *duplicative research paths* in Katsoulacos and Ulph (1998). In the second stage, firms decide simultaneously whether to integrate or not. Following Inderst and Wey (2005), we assume that there is only a bilateral integration between firms because the antitrust authority blocks an integration to monopoly. Note that when firms decide whether to integrate or not, their R&D expenses have been sunk. This implies that the integration decision is based on gross profits, instead of net, i.e., firms do not take into account the cost for their R&D investments. We further consider that the integration can be carried out through one among the following two types, that differ on the rule of sharing of the integrated firm's gross profits across participants. The first one is the *acquisition*-type of integration: in this case, the bidder firm, by paying a purchase price, acquires the target firm. The second one is the *merger*-type of integration: in this case, the merger participants share the integrated firm's gross profits based on a pre-merger exogenously determined rule.

[4] This quadratic R&D cost specification implies diminishing returns to R&D expenditures. See d'Aspremont and Jacquemin (1988).

The type of integration is assumed to be exogenously given. Independently of the type of integration chosen, if it is carried out, the integrated firm produces all its output with the minimum of the marginal costs of its constituent parts and the less efficient participant shuts down. Thus, the integration entails endogenous efficiency gains that arise from the reallocation of production to the most efficient participant. Finally, in the third stage, firms compete *a là* Cournot. The rationale behind this sequence of moves is the following: both investments in R&D and whether to integrate or not are long-term decisions; but firms decide on their R&D investments in the prospect of the integration decision.[5]

In this context, we propose a candidate equilibrium configuration, assigning a special role to each firm. Then, we check whether, or not, it survives all possible deviations, in roles and configurations. This means that, given the R&D investments, all firms are allowed to choose whether to integrate and with whom.

3 The *No-integration* case

We begin our analysis by considering the *no-integration* candidate equilibrium. In the third stage of the game each firm i chooses its output level to maximize gross profits given by:

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

where the superscript N denotes the *no-integration* case.

Taking the first order conditions and solving the system of equations, firm i's output level is given by:

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

x_{-i}^N is the sum of firm i's competitors R&D investments. Substituting $q_i^N(x_i^N, x_{-i}^N)$ in eq. (2), we find firm i's gross profits $\pi_i^N(x_i^N, x_{-i}^N) = \left[q_i^N(x_i^N, x_{-i}^N)\right]^2$.

[5] A reverse timing of the investment and integration decision stages has been employed in the literature too (Davidson and Ferrett, 2007; Banal-Estañol et al., 2008). The latter timing reflects the idea that the integration aims at the coordination of the (formerly separate) firms' investments, in order to exploit investment complementarities that will reduce the integrated entity's marginal cost even below that of the more efficient participant's.

In the second stage of the game, firms' decision whether to integrate or not is depicted by an indicator function I_i that takes the value 0 if firm i does not integrate and the value 1 if firm i integrates. Since the case under consideration is that of *no-integration,* the second stage is characterized by the strategy vector: $(I_1, I_2, I_3) = (0, 0, 0)$.

In the first stage, each firm i chooses its R&D investment so as to maximize its net (from R&D expenses) profits, given by:

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

Solving the system of first-order conditions and using eq. (3) and (4), we find firm i's equilibrium level of R&D, output and net profits:

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

Note that the necessary stability condition for the equilibrium, that is the condition in order for the reaction function to cross in the positive quadrant, is $\gamma > \frac{3}{2}$. The equilibrium outcomes suggest that the more effective the R&D, i.e., the lower the value of γ, the higher the levels of R&D, output and profits. Clearly, the industry levels of R&D, output and profits are the sum of the respective variables of the three firms under consideration, i.e., $\sum_{i=1}^3 x_i^N$, $\sum_{i=1}^3 q_i^N$, $\sum_{i=1}^3 \Pi_i^N$.

Given the R&D investments vector $X^N = \begin{bmatrix} x_1^N & x_2^N & x_3^N \end{bmatrix}$, let us now investigate whether two firms have incentives to integrate. If the integration were to be formed, regardless of the type chosen, the constituent parts of the integrated firm would have equal marginal costs, implying that the integrated firm could not reallocate the production and exploit efficiency gains. In this context, we know from the seminal paper of Salant et al. (1983) that in a triopoly with homogeneous goods, Cournot competition, linear demand and equal marginal costs, the integration of two firms is not profitable. The following Proposition summarizes:

Proposition 1 *No-integration is an equilibrium for all parameter values.*

Proof. Results follow directly from Salant et al. (1983). ■

4 The *Acquisition*-type of integration

In this section, we consider that two firms (suppose 1 and 3) integrate through the acquisition-type of integration. In particular, the firm 1, by paying a purchase price, acquires firm 3 and forms the post-acquisition firm u.

In the third stage of the game, given the R&D investments and the realized acquisition, the integrated firm u and the outsider firm 2 set output so as to maximize gross profits given by:

$$\pi_i^A = (a - q_i^A - q_j^A)q_i^A - (c - x_i^A)q_i^A, \; i,j = u, 2, \; i \neq j \tag{6}$$

where the superscript A denotes the acquisition-type of integration. Taking the first order conditions of eq. (6) and solving the system of equations, output level is given by:

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

with the corresponding gross profits equal to $\pi_i^A \left(x_i^A, x_j^A\right) = \left[q_i^A \left(x_i^A, x_j^A\right)\right]^2$.

Since the case under consideration is that of acquisition, the second stage of the game is characterized by the strategy vector: $(I_1, I_2, I_3) = (1, 0, 1)$.

In the first stage of the game, the three firms invest in R&D so as to maximize net profits, given by:

$$\Pi_1^A = \left[\frac{1}{3}(\alpha - c + 2x_1^A - x_2^A)\right]^2 - \frac{1}{2}\gamma(x_1^A)^2 - \left[\frac{1}{4}(\alpha - c - x_1 - x_2^A + 3x_3^A)\right]^2 \tag{8}$$

$$\Pi_2^A = \left[\frac{1}{3}(\alpha - c + 2x_2^A - x_1^A)\right]^2 - \frac{1}{2}\gamma(x_2^A)^2 \tag{9}$$

$$\Pi_3^A = \left[\frac{1}{4}(\alpha - c - x_1 - x_2^A + 3x_3^A)\right]^2 - \frac{1}{2}\gamma(x_3^A)^2 \tag{10}$$

Observe that the bidder firm 1's profits, given by eq. (8), consist of two parts. The first depicts the firm 1's net profits in the post-acquisition duopoly. The second depicts the cost of acquiring the target firm 3 and is equal to the latter's purchase price. Eq. (9) depicts the firm

2's net profits in the post acquisition duopoly. In turn, eq. (10) provides the target firm 3's net profits that are equal to its purchase price minus the R&D costs that this firm undertakes in order to maximize its purchase price. Note that the target firm's purchase price is equal to its gross profits in the *no-integration* case. This implies that the target firm accepts the purchase price offered by the bidder only if it guarantees gross profits at least equal to those earned in the no-integration case.

The corresponding reaction functions for the three firms are:

$$R_1^A(x_2^A, x_3^A) \equiv x_1^A = \frac{41\left(a - c - x_2^A\right) + 27x_3^A}{72\gamma - 55}$$

$$R_2^A(x_1^A) \equiv x_2^A = \frac{4\left(a - c - x_1^A\right)}{9\gamma - 8}$$

$$R_3^A(x_1^A, x_2^A) \equiv x_3^A = \frac{3\left(a - c - x_1^A - x_2^A\right)}{8\gamma - 9}$$

Regarding the strategic relationship among the R&D investments of the three firms, two observations are in order. First, the R&D investments between the bidder and the target are strategic complements, that is $dx_1^A/dx_3^A > 0$. Intuitively, as the target increases its R&D in order to increase its purchase price, the acquirer also increases its own R&D in order to increase its profits net from the purchase price. Second, as expected, the R&D investments between the bidder and the outsider firm are strategic substitutes, i.e., $dx_1^A/dx_2^A < 0$.

Solving the system of reaction functions, the R&D investments vector is given by $X^A = \left[x_1^A \;\; x_2^A \;\; x_3^A\right]$, with $x_1^A > x_2^A > x_3^A$ which results in $c_1^A < c_2^A < c_3^A$. Observe that the post-acquisition firm's production will be reallocated to the bidder firm, since $c_u = min\{c_1, c_3\} = c_1$, while the target firm will shut down. Note also that although the target anticipates its own shutdown, it invests in R&D in order to maximize its purchase price, obliging the bidder to increase its R&D, in order to maximize its profits net from the purchase price. It is precisely the bidder's and the targets strategic R&D behavior that induces wasteful duplication of R&D activities and increases the integration's cost.

Substituting X^A into eq. (7), (8), (9) and (10) gives the equilibrium output and net profits.[6] It also provides the necessary stability condition $\gamma > \frac{3}{2}$. The industry levels of R&D, output and net profit are the sum of the respective variables of the firms under consideration, i.e., $\sum_{i=1}^{3} x_i^A, \sum_{i=u,2} q_i^A, \sum_{i=1}^{3} \Pi_i^A$.

Let us now investigate the conditions under which, the proposed acquisition will be carried out. We identify two sets of incentive compatibility conditions that must hold. The first set contains the "participation conditions". Namely, firms 1 and 3 have incentives to participate in the proposed acquisition only if each firm's gross profits exceed the corresponding profits in the *no-integration* scenario, given the R&D investment vector X^A. More formally, the participation conditions can be written:

$$\text{Participation conditions} \left\{ \; \pi_i^A(X^A) > \pi_i^N(X^A) \right. \text{ , with } i = 1, 3.$$

The second set contains the "stability conditions". Namely, the acquisition between firms 1 and 3 is stable only if each firm's gross profits exceed the corresponding profits that each of them would earn under any other acquisition configuration. Since the antitrust authority blocks the formation of a monopoly, the acquisition configurations that have to be checked, as deviations from the proposed one, are the following: B: {firm 1 acquires firm 2}, C: {firm 2 acquires firm 1}, D: {firm 3 acquires firm 1}, E: {firm 2 acquires firm 3}, F: {firm 3 acquires firm 2}. The stability conditions are formalized as follows:

$$\text{Stability conditions} \left\{ \begin{array}{c} \Pi_i^{A\{1+3\}}(X^A) > \pi_i^d(X^A) \\ \text{with } i = 1, 2, 3. \\ \text{and } d = B, C, D, E, F. \end{array} \right.$$

Applying the participation and the stability conditions, we derive the following Proposition:

Proposition 2 *There is a unique stable acquisition where firm 1 acquires firm 3, if and only if* $\gamma < 3.666$.

Proof. see Appendix A2. ■

[6] Equilibrium outcomes are given in Appendix A1.

The intuition behind this result goes as follows. Firms' 1 and 3 incentives for the acquisition depend on three effects: firstly, the *rationalization of production* affects positively the profits of the post-acquisition firm, since production is reallocated to the most efficient participant while the less efficient is compensated and shuts down. On the other hand, the *business stealing* affects negatively the post-acquisition firm's profits, as a result of the increased sales that the outsider firm enjoys (Stigler 1950; Salant et al., 1983). Yet, the post-acquisition firm's profits are negatively affected by the *wasteful duplication of R&D activities* because of the target firm's strategic behavior that increases the cost of the integration.

We find that the rationalization of production effect dominates both the business stealing and the wasteful duplication of R&D effects, when the R&D investments are sufficiently effective in the reduction of the marginal cost, i.e. when $\gamma < 3.666$. We also find that in equilibrium, the purchase price that the acquirer offers to the target is equal to the gross profits that the target would earn in the *no-integration* case, given the vector X^A.

Restricting our attention to the stability conditions, the intuitive explanation behind their validity goes as follows: first, the firm 2's gross profits are higher in the proposed configuration {firm 1 acquires firm 3} rather than under configurations B, E and F. This happens because the firm 2's gross profits are higher as being the outsider, rather than being either the bidder (configuration E) or the target (configurations B, F). For this reason, the configurations B, E and F will never be realized. Second, the firm 1 prefers to bid for the firm 3, instead of being the target either of the firm 2 or of the firm 3. This happens because the firm 1' s purchase price is the highest, compared with the corresponding of the other two firms, due to its relatively higher R&D investments (recall that $x_1^A > x_2^A > x_3^A$). Thus, configurations C and D will never be realized.

We also investigate whether the outsider firm 2, by strategically investing in R&D, can induce firms 1's and 3's incentives for acquisition when there are no such, i.e. when $\gamma > 3.666$. Since $dx_1^A/dx_2^A < 0$, the firm 2 could decrease its R&D investments to a level $x_2^{dA} < x_2^A$, making the firm 1 to respond optimally and increase its own R&D to $x_1^{dA} > x_1^A$. At the same time, since $dx_3^A/dx_1^A > 0$, the firm 3 would respond optimally to the firm 1, by increasing its R&D to the level $x_3^{dA} > x_3^A$. It can be proved that when $\gamma > 3.666$, $\pi_1^N[x_1^{dA}(x_2^{dA}), x_2^{dA}, x_3^{dA}(x_2^{dA})] > \pi_1^A[x_1^{dA}(x_2^{dA}), x_2^{dA}, x_3^{dA}(x_2^{dA})]$, implying that when the bidder firm has no incentives for acquisition, the firm 2 can not induce such.

The above analysis suggests that there is a unique stable acquisition, where the most efficient firm in the industry acquires the least efficient one. It is precisely these cost asymmetries that allow the target firm to arise endogenously. This is in contrast to Inderst and Wey (2005), where the target firm is exogenously picked among symmetric competitors.

Then, another natural question relates to the comparison between the levels of output, R&D and profits between the *no-integration* and the *acquisition* equilibria. Our findings are summarized in the following Corollary:

Corollary 1. *(i)* $q_u^A < 2q_i^N$, $q_2^A > q_i^N$, $q_u^A > q_2^A$, $\sum_{i=1}^{3} q_i^N > \sum_{i=u,2} q_i^A$.

(ii) $x_1^A > x_2^A > x_3^A$, $\sum_{i=1}^{3} x_i^A > \sum_{i=1}^{3} x_i^N$.

The first part of Corollary 1 stresses the business stealing effect that the outsider firm exploits in the output competition stage. Given that the outputs of the firms are strategic substitutes, the outsider firm increases its R&D investments ($x_2^A > x_i^N$) and expands its production $\left(q_2^A > q_i^N\right)$, compared to the symmetric pre-integration industry. Hence, the post-acquisition firm's output is lower than the combined, pre-acquisition production of its participants ($q_u^A < 2q_i^N$).

Regarding the second part of Corollary 1, recall that the target firm 3 invests in R&D in order to extract the maximum purchase price. In response, the acquirer invests in R&D even more in order to increase its profits net from the purchase price. Recall that $dx_1^A/dx_3^A > 0$. 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 firm's output exceeds the outside firm's output. Note also that $x_1^A > x_i^N$ if and only if $\gamma > 1.8$, $x_2^A > x_i^N$, $x_3^A < x_i^N$, and $x_1^A + x_3^A > 2x_i^N$.

5 The *Merger*-type of integration

In this section, we study the *merger*-type of integration. In particular, we consider that two firms (suppose 1 and 3) integrate and from the firm m. In the third stage of the game, given the R&D and the realized merger, the integrated firm m and the outside firm 2 compete by choosing output in order to maximize gross profits given by eq. (6), with $i, j = m, 2$, $i \neq j$. Naturally, the second stage of the game is characterized by the strategy vector: $(I_1, I_2, I_3) = (1, 0, 1)$.

Not that if the merger is going to be formed, the participating firms will share the merged firm's gross profits based on a pre-merger exogenously determined rule. This implies that in the first stage of the game, firms 1 and 3 anticipate the merger and one of them (assume firm 3) abstains from investing in R&D in order to avoid the wasteful duplication of R&D activities. As a result, the firms 1 and 2 choose their R&D investments (x_1^M and x_2^M respectively) so as to maximize their net profits, given by:[7]

$$\Pi_1^M = \beta * \left[\frac{1}{3}(\alpha - c + 2x_1^M - x_2^M)\right]^2 - \frac{1}{2}\gamma(x_1^M)^2, \ \beta \in [0, 1] \tag{11}$$

$$\Pi_2^M = \left[\frac{1}{3}(\alpha - c + 2x_2^M - x_1^M)\right]^2 - \frac{1}{2}\gamma(x_2^M)^2 \tag{12}$$

In eq. (11), the parameter $\beta \in [0, 1]$ denotes the share of the merged firm's gross profits that the firm 1 will receive, if the proposed merger is formed. In this case, the merged firm's gross profits, π_m^M, will be shared to its participants as follows:

$$\pi_1^M(x_1^M, x_2^M) = \beta * \pi_m^M(x_1^M, x_2^M) \tag{13}$$

$$\pi_3^M(x_1^M, x_2^M) = (1 - \beta) * \pi_m^M(x_1^M, x_2^M) \tag{14}$$

The above formalization reveals a crucial difference between the acquisition-type of integration and the merger one. In particular, in the former, the target firm invests in R&D in order to maximize its purchase price, which results in wasteful duplication of R&D activities. In the latter instead, one of the participants abstains from investing in R&D and avoid the aforementioned the duplication.

From eq. (11) and (12), the corresponding reaction functions for the two firms are:

$$R_1^M(x_2^M) \equiv x_1^M = \frac{4\beta\left(a - c - x_2^M\right)}{(9\gamma - 8\beta)}; \ R_2^M(x_1^M) \equiv x_2^M = \frac{4\left(a - c - x_1^M\right)}{(9\gamma - 8)}$$

These reaction functions imply that the R&D investments between firms 1 and 2 are strate-

[7] The superscript M denotes the acquisition-type of integration.

gic substitutes, that is $dx_1^M/dx_2^M < 0$, in line with the acquisition-type. Solving the system of reaction functions, the R&D investments vector is given by $X^M = \begin{bmatrix} x_1^M & x_2^M & 0 \end{bmatrix}$, with $x_1^M < x_2^M$ and subsequently, $c_2^M < c_1^M < c_3^M$. This means that the post-merger firm's production will be reallocated to firm 1, since it is the most efficient participant while firm 3 will shut down.

Substituting X^M into eq. (7), (14), (11) and (12) gives the equilibrium output and net profits.[8] It also provides the necessary stability condition $\gamma > \frac{4}{3}$. The industry levels of R&D, output and net profit are the sum of the respective variables of the two firms under consideration, i.e., $\sum_{i=1,2} x_i^M$, $\sum_{i=m,2} q_i^M$, $\sum_{i=m,2}^M \Pi_i^M$.

In order for the proposed merger configuration to be realized, the participation and the stability sets of conditions must hold. Regarding the former set, firms 1 and 3 have incentives to participate in the proposed merger, only if each firm's gross profits exceed the corresponding profits in the *no-integration* scenario, given the R&D investment vector X^M.[9] More formally, the participation conditions can be written:

$$\text{Participation conditions} \begin{cases} \pi_1^M(X^M) = \beta\pi_m^M(X^M) > \pi_1^N(X^M) \\ \text{and} \\ \pi_3^M(X^M) = (1-\beta)\pi_m^M(X^M) > \pi_3^N(X^M) \end{cases}$$

The latter condition implies that firm 3 will agree to merge only if the compensation that it receives to shut down is higher than the profits that it would earn in a triopoly, given the R&D investment vector X^M.

For the stability conditions to hold, the gross profits that each merger participant receives must exceed the profits that it would receive under any other merger configuration. Since the antitrust authority blocks the formation of a monopoly, the merger configurations that have to be checked, as deviations from the proposed one, are: B: {firm 1 merges with firm 2} and C: {firm 2 merges with firm 3}.[10] More formally, the stability conditions can be written:

[8] Equilibrium outcomes are given in Appendix A3.

[9] In Barros (1998), the participation conditions are formalized differently. More specifically, he argues that firms have incentives to participate in a merger if "the profit of the firm resulting from the merger exceeds the sum of pre-merger profits of participating firms". The difference exists because in Barros (1998) the integration decision is based on net profits. On the contrary, in the present paper this decision is based on gross profits, because when firms decide whether to integrate or not their R&D expenses are sunk.

[10] In Barros (1998), the stability conditions are formalized differently. He assumes that a merger between firms i and j $\{i+j\}$ is stable if the outsider firm k, although willing to offer the maximum share either to i (in

$$\text{Stability conditions} \begin{cases} \pi_i^{M\{1+3\}}(X^M) > \pi_i^d(X^M) \\ \text{with } i = 1,2,3. \\ \text{and } d = B\{1+2\}, C\{2+3\}. \end{cases}$$

Applying the participation and the stability conditions, we derive the following Proposition:

Proposition 3 *There is a unique stable merger between firms 1 and 3, if* $\widehat{\beta}_1(\gamma) \leq \beta \leq \widehat{\beta}_3(\gamma)$ *with* $\frac{d\widehat{\beta}(\gamma)}{d\gamma} < 0$, $\beta_{\min} = 0.64$ *and* $\beta_1(4/3) = \beta_3(4/3) = 1$.[11]

Proof. see Appendix A4. ■

Graphically, Proposition 1 is depicted in Figure 1. The area where both the participation and the stability conditions hold is the horizontally and vertically shaded area. For firm 1, it includes the area where the share of the merged firm's gross profits that it will receive is sufficiently high, i.e., $\beta > \widehat{\beta}_1(\gamma)$. Note that the minimum share that firm 1 requires in order to participate is almost 2/3 of the gross profits ($\beta_{\min} = 0.64$). As it was expected, the more effective the R&D, the higher the share required by firm 1. This is described by the relation $d\widehat{\beta}(\gamma)/d\gamma < 0$. However, given the constraint $\gamma > 4/3$, firm 1 is not able to realize the total amount of gross profits of the merger that requires $\gamma = 4/3$ [$\beta(4/3) = 1$]. Firm 3 in turn, participates in the merger only if its share of the merged firm's gross profits satisfies $\beta < \widehat{\beta}_3(\gamma)$, i.e., firm 1 receives a sufficiently low share of gross profits.

Regarding the stability conditions, we find that the configurations $\{1+2\}$ and $\{2+3\}$ will never be realized and the proposed merger $\{1+3\}$ is stable. Intuitively, given the R&D investment vector X^M, the firm 2's gross profits are higher as being the outsider, in the merger configuration $\{1+3\}$, rather than being a participant either in the configuration $\{1+2\}$ or in the $\{2+3\}$. This happens because of the business stealing effect that firm 2 exploits in the output stage.[12]

$\{i+k\}$) or to j (in $\{j+k\}$), provided that k does not end worse than in $\{i+j\}$, he can not break the merger $\{i+j\}$. This can be the polar case of a bargaining process where the outsider firm has all the bargaining power.

[11] $\widehat{\beta}_1(\gamma) = \frac{9}{4}(2\gamma^2 - \gamma - 2\sqrt{\gamma^4 - \gamma^3})$ *and* $\widehat{\beta}_3(\gamma) = \frac{1}{4}(3\gamma - 2\gamma^2 + 2\sqrt{4\gamma^2 - 3\gamma^3 + \gamma^4})$.

[12] If we apply the stability conditions in the spirit of Barros (1998), we find that the unique stable merger is formed between firms 1 and 2 (1 and 3), if $\gamma \leq \widehat{\gamma}(\beta)$ ($\gamma > \widehat{\gamma}(\beta)$) with $\frac{d\widehat{\gamma}(\beta)}{d\beta} < 0$, $\widehat{\gamma}(\beta) = \frac{20+4\sqrt[3]{\Gamma}}{27} - \frac{174960\beta - 291600}{78732\sqrt[3]{\Gamma}}$, $\Gamma = 125 - 153\beta + 3\sqrt{3}\sqrt{125\beta^3 + 242\beta^2 - 375\beta}$. The detailed analysis is available from the authors upon request.

Since the stable merger benefits firm 2, it has to be checked whether this firm can induce firms 1's and 3's incentives for this merger, when there are no such, i.e. when $\beta \notin [\widehat{\beta}_1(\gamma), \widehat{\beta}_3(\gamma)]$. More specifically, given that the R&D investments between firms 1 and 2 are strategic substitutes, the firm 2 could decrease its R&D to a level $x_2^{dM} < x_2^M$, making the firm 1 to respond optimally and increase its own R&D to $x_1^{dM} > x_1^M$, in order to make the merger profitable. It can be proved that when $\beta \notin [\widehat{\beta}_1(\gamma), \widehat{\beta}_3(\gamma)]$, $\pi_1^N[x_1^{dM}(x_2^{dM}), x_2^{dM}] > \pi_1^M[x_1^{dM}(x_2^{dM}), x_2^{dM}]$, implying that when there are no incentives for merger, the firm 2 can not induce such. This happens because $\left|d\pi_1^N/dx_2\right| > \left|d\pi_1^M/dx_2\right|$.

Despite the aforementioned free-riding externality, Proposition 2 states that a unique stable merger is formed between the two least efficient firms, namely firms 1 and 3. On the contrary, Barros (1998) and Straume (2006) find multiple equilibria, depending on the degree of cost asymmetries across firms in the industry. In particular, for moderate cost asymmetries, they demonstrate that the merger occurs among the least and the most efficient firm. If instead the cost asymmetries are large, Barros (1998) finds that the merger takes place between the two most efficient firms, while in Straume (2006), the merger occurs among either the less and the most efficient firm or the two least efficient firms.

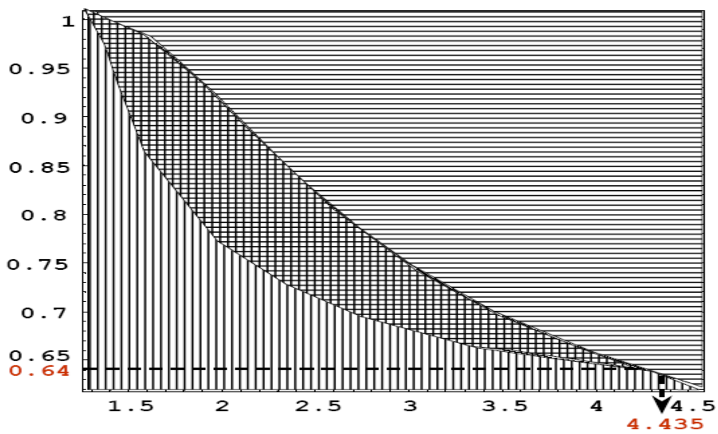

Figure 1: Firms' incentives for merger

Comparing the equilibrium levels of output, R&D and profits between the *no-integration* and the *merger* equilibria, we summarize our findings in the following Corollary:

Corollary 2. *(i)* $q_m^M < 2q_i^N$, $q_2^M > q_i^N$, $q_2^M > q_m^M$, $\sum_{i=m,2} q_i^M < \sum_{i=1}^3 q_i^N$.

(ii) $x_1^M < 2x_i^N$, $x_2^M > x_i^N$, $x_2^M > x_1^M$, $\sum_{i=1,2} x_i^M < \sum_{i=1}^3 x_i^N$.

The first part of Corollary 2 presents results similar to those stated in the first part of Corollary 1. This is not the case, however, with the second part of Corollary 2. More specifically, we find that the rationalization effect encourages firm 3 to abstain from R&D investing. Thus, the merged firm's R&D investments are lower than the combined pre-merger investments of the participants ($x_1^M < 2x_i^N$). Since R&D investments are strategic substitutes, the outsider firm invests more than firm 1, resulting in $x_2^M > x_1^M$, which in turns implies that $q_2^M > q_m^M$. At the industry level, both total R&D and total output are lower than the corresponding levels in the no-integration case.

6 Welfare analysis

In this Section, we examine the impact of horizontal integrations on welfare and discuss the policy implications of our findings. Total welfare is defined as the sum of consumers and producers surplus:

$$TW^S = T\Pi^S + CS^S, \; S = N, \; A, \; M \tag{15}$$

with $T\Pi^S$ and $CS^S = \frac{1}{2}\left(TQ^S\right)^2$ corresponding to the overall industry profits and consumers surplus respectively.[13] The superscripts N, A, M, correspond to *no-integration*, *acquisition* and *merger* respectively. Following the seminal analyses of Williamson (1968) along with Farrell and Shapiro (1990), we first consider that the antitrust authority approves the integration only if it enhances total welfare. We summarize our findings in the following Proposition:

Proposition 4 *The antitrust authority approves:*

(i) the acquisition-type of integration if $\gamma < 1.915$.

(ii) the merger-type of integration if $\gamma < \widehat{\gamma}(\beta)$ *with* $\frac{d\widehat{\gamma}(\beta)}{d\beta} > 0$, $\widehat{\gamma}(0) = 2.144$ *and* $\widehat{\gamma}(1) = 3.124$.

[13] Total welfare for each candidate equilibrium is given in Appendix A5.

The intuition is straightforward. Firms' integration has two opposing effects on total welfare. On the one hand, the rationalization of production creates efficiency gains that tend to increase overall industry profits and consumers surplus. On the other hand, the horizontal integration increases market concentration, implying a higher price, higher industry profits and lower consumers surplus. Our analysis reveals that in order for the cost efficiency effect to offset the dead-weight loss, the effectiveness of the R&D technology must be sufficiently high.

A number of observations are in order. First, the effectiveness of the R&D investments that guarantees a welfare-enhancing horizontal integration (under both types) is higher than that required for private profit-enhancing. This finding underlines the significant contradiction between private and social incentives for a horizontal integration. Second, the respective effectiveness that guarantees a welfare-enhancing acquisition is higher than that for a welfare-enhancing merger. This happens because of the dead-weight loss caused by the target firm's strategic behavior, in the case of acquisition, that increases the cost of the integration and reduces the profits of the post-acquisition firm. The latter underlines that the range of the R&D technology's effectiveness for which the antitrust authority should hinder an acquisition is much wider than that for a merger to be hindered. For the rest of the technology's effectiveness rates, the antitrust authority should approve the horizontal integration.

A note should be made regarding the welfare standard under consideration. By assessing the welfare effects of the integration through the total welfare standard, the antitrust authority may approve integrations that lead to higher price provided that the gains realized by producers exceed the losses experienced by consumers. In consequence, the total welfare standard does not examine whether consumers experience any benefit from an integration. Of course, an antitrust authority can investigate this by assessing the integration's welfare effects through the consumers surplus standard.[14] Our analysis reveals that $CS^M < CS^N$ and $CS^A < CS^N$ always hold. This implies that there is no transfer of wealth gains from producers to consumers, under both types of integration.

Our findings suggest that the design of competition policies for the assessment of horizontal M&As should make a careful account of the industry and the proposed integration under

[14]Recall that this is the welfare standard adopted in the US Department of Justice Merger Guidelines and the European Merger Guidelines. See footnote 3.

consideration. In particular, the welfare standard for the assessment of horizontal M&As in an industry could be determined by this industry's relative weight on the competitiveness of the national economy. This implies that the antitrust authority might approve integrations that lead to short run losses for consumers, provided that they will be compensated in the long run. Moreover, the relative efficiency of the proposed integration's participants and the transaction through which the integration will take place, should also be taken into account by the antitrust authority, in the evaluation of horizontal integrations.

7 Discussion: Merger vs. Acquisition

In this section we compare the equilibrium outcomes between the acquisition- and the merger-type of integration. These two types are found to differ with respect to both incentives and equilibrium outcomes. Interestingly, we find that the post-acquisition firm is more efficient than the post-merger one, i.e., $x_1^A > x_1^M$. Given that R&D investments are strategic substitutes in the post-integration duopoly, it is straightforward that the outsider firm's investments in the case of merger are higher from the corresponding in the acquisition, i.e., $x_2^A < x_2^M$. Note also that the target firm's R&D investments, in order to maximize its purchase price, results in a relative "overinvestment" in R&D in the acquisition-type of integration, i.e., $\sum_{i=1}^{3} x_i^A > \sum_{i=1,2} x_i^M$. The same inequality holds for industry-output and consumers surplus.

Concentrating on profits, we find that the post-acquisition firm's net profits exceed the corresponding of the post-merger one, if the effectiveness of R&D investments is sufficiently high, i.e. $\gamma < \widehat{\gamma}(\beta)$, with $\frac{d\widehat{\gamma}(\beta)}{d\beta} < 0$ in the relevant range where the merger is an equilibrium. It is the target firm's strategic behavior in the case of acquisition that increases the integration's cost and reduces the profits of the post-acquisition firm. Since $x_2^A < x_2^M$, the outside firm's net profits in case of merger $\left(\Pi_2^M\right)$ are higher than the corresponding in the acquisition-type of integration $\left(\Pi_2^A\right)$.

Another difference between the merger and the acquisition has to do with the efficiency of the integration participants. More specifically, in the merger equilibrium ($x_2^M > x_1^M > x_3^M = 0$), the second most efficient firm (firm 1) merges with the least efficient one (firm 3). On the contrary, in the acquisition equilibrium ($x_1^A > x_2^A > x_3^A$), it is the most efficient firm (firm 1) that acquires the least efficient one (firm 3).

Last but not least, we find that the minimum effectiveness of the R&D investments for the stable acquisition is higher than the corresponding for the stable merger (see Propositions 2 and 3). The respective effectiveness that guarantees a welfare-enhancing acquisition is also higher than that for a welfare-enhancing merger (see Proposition 4). These result from the structure of the acquisition case: the target firm's strategic behavior increases the cost of the acquisition and demands the effectiveness of the R&D investments, on the reduction of the marginal cost, to be higher, relative to the merger, so as the efficiency gains to offset the business stealing and the wasteful duplication of R&D.

8 Concluding remarks

We have analyzed how do pre-integration long-run decisions in cost-reducing R&D investments create endogenous efficiency gains that result in profitable horizontal integrations; and what are the welfare effects of these integrations. Two different types of integration were formalized: the *acquisition*, where the bidder firm, by paying a purchase price, acquires the target firm; and the *merger*, where the participants share the integrated firm's profits based on a pre-merger exogenously determined rule.

We have shown that in the acquisition-type of integration the target firm invests in R&D so as to maximize its purchase price, inducing wasteful duplication of R&D activities and making the stable and welfare-enhancing acquisition to require relatively more effective R&D investments than the merger. In the unique stable acquisition, the most efficient firm in the industry acquires the least efficient one. In the merger-type instead, the one of the merger participants abstains from investing in R&D, while the unique stable merger is formed between the two least efficient firms in the industry.

Regarding the welfare implications of horizontal M&As, we have demonstrated that they should not be allowed unless they lead to significant efficiency gains. We have also stressed the significant contradiction between private and social incentives for a horizontal integration. Moreover, policy measures for the assessment of horizontal M&As should carefully be designed, taking into account the relative efficiency of the participating firms. While this policy implication should be taken with caution, due to the simplicity of the setting under consideration, our conclusion that the participants' efficiency is crucial both for the private incentives and for the welfare effects of such integrations seems to be of a more general applicability.

Our findings provide some guidelines for future empirical research on the horizontal M&As with efficiency gains literature which, as mentioned above, is so far inconclusive as regards the sources and the effects of these gains. Empirical analyses should begin with a detailed record of the participating firms, regarding their cost and demand structure and their relative efficiency. Then, they should proceed with a classification, regarding the transactions through which integrations were formed; and in particular, whether each integration was in the spirit of the merger or the acquisition. A number of testable hypotheses emerge from our analysis. A first testable hypothesis is that the higher the asymmetry across participants, the stronger the efficiency gains that the integrated entity exploits and the higher its profits. A second testable hypothesis is that integrations of the merger-type are expected to be formed among firms with relatively symmetric efficiency, while in integrations of the acquisition-type a relatively highly efficient firm is expected to bid for a sufficiently less efficient firm.

In our analysis we have considered that the integration is carried out through either a merger or an acquisition process. An interesting direction for further research would be to generalize the integration decision as the outcome of a generalized Nash bargaining problem. By doing so, we would link the literature for M&As with that for non-cooperative bargaining (Binmore et al., 1986). Another interesting direction would be to consider that firms have capacity constraints so that the production can not be fully reallocated towards the plant with the relatively lower marginal cost.

Appendix

A1. Equilibrium outcomes for the *Acquisition*-type of integration

$$x_1^A = \frac{(41\gamma - 36)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)}; \;\; x_2^A = \frac{(8\gamma - 9)(\alpha - c)}{18\gamma^2 - 26\gamma + 9}; \;\; x_3^A = \frac{9(3\gamma - 4)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)}$$

$$q_u^A = \frac{3\gamma(4\gamma - 3)(\alpha - c)}{2(18\gamma^2 - 26\gamma + 9)}; \qquad q_2^A = \frac{3\gamma(8\gamma - 9)(\alpha - c)}{4(18\gamma^2 - 26\gamma + 9)}$$

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

$$\Pi_2^A = \frac{\gamma\left(9\gamma - 8\right)\left(8\gamma - 9\right)^2(\alpha - c)^2}{16\left(18\gamma^2 - 26\gamma + 9\right)^2}; \ \Pi_3^A = \frac{9\gamma\left(8\gamma - 9\right)\left(3\gamma - 4\right)^2(\alpha - c)^2}{32\left(18\gamma^2 - 26\gamma + 9\right)^2}$$

A2. Proof of Proposition 1

Participation conditions

Given the R&D investments vector $X^A = \left[x_1^A \ \ x_2^A \ \ x_2^A\right]$, the gross profits that the bidder firm earns in case of acquisition are:

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

Given X^A, if the firm 1 deviates from the *acquisition* equilibrium towards the *no-integration* one, the standing-alone gross profits that it earns are given by $\pi_1^N(x_1^A, x_2^A, x_3^A) = \left[q_1^N(x_1^A, x_2^A, x_3^A)\right]^2$. Thus, firm 1 receives:

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

The firm 1 has incentives for merger as long as $\pi_1^A(x_1^A, x_2^A, x_3^A) > \pi_1^N(x_1^A, x_2^A, x_3^A)$, a condition that holds if $\gamma < 3.666$.

In the same lines, the gross profits that the target firm earns in case of acquisition are:

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

Given X^A, if the firm 3 deviates from the *acquisition* equilibrium towards the *no-integration* one, the standing-alone gross profits that it earns are given by $\pi_3^N(x_1^A, x_2^A, x_3^A) = \left[q_3^N(x_1^A, x_2^A, x_3^A)\right]^2$. Thus, firm 3 receives:

$$\pi_3^N(x_1^A, x_2^A, x_3^A) = \pi_3^A(x_1^A, x_2^A, x_3^A)$$

The firm 3 is indifferent for the acquisition, for all parameter values.

Stability conditions

Given the R&D investments vector X^A, suppose that firms 1 and 2 deviate from the proposed acquisition configuration {firm 1 acquires firm 3} towards the configuration B{firm 1 acquires firm 2}. Since $x_1^A > x_2^A$, the post-acquisition firm firm u will produce its output with the firm 1's technology.

If the firm 1 deviates from the proposed acquisition {firm 1 acquires firm 3} towards the bidding for the firm 2, firm 1 earns:

$$\pi_1^{\{1+2\}}(x_1^A, x_2^A, x_3^A) = \frac{\gamma^2\left(567\gamma^2 - 225\gamma - 212\right)(a-c)^2}{16(18\gamma^2 - 26\gamma + 9)^2}$$

It can be checked that the firm 1 has no incentives for deviation towards bidding for the firm 2 as long as $\pi_1^{\{1+2\}}(x_1^A, x_2^A, x_3^A) < \pi_1^{\{1+3\}}(x_1^A, x_2^A, x_3^A)$ always holds.

In the same lines, if the firm 2 deviates from being the outsider towards being bidded from the firm 1, it earns:

$$\pi_2^{\{1+2\}}(x_1^A, x_2^A, x_3^A) = \frac{\gamma^2\left(19 - 18\gamma\right)(a-c)^2}{16(18\gamma^2 - 26\gamma + 9)^2}$$

It can be checked that the firm 2 has no incentives for deviation towards being bidded from the firm 1 as long as $\pi_2^{\{1+2\}}(x_1^A, x_2^A, x_3^A) < \pi_2^{\{1+3\}}(x_1^A, x_2^A, x_3^A)$ always holds.

Applying the above steps, it is also proved that there are no incentives for deviation towards the acquisition configurations C, D, E and F.

A3. Equilibrium outcomes for the *Merger*-type of integration

$$x_1^M = \frac{4\beta(3\gamma-4)(a-c)}{3\gamma(9\gamma-8) - 8\beta(3\gamma-2)};\quad x_2^M = \frac{4(3\gamma-4\beta)(a-c)}{3\gamma(9\gamma-8) - 8\beta(3\gamma-2)}$$

$$q_m^M = \frac{3\gamma(3\gamma-4)(a-c)}{3\gamma(9\gamma-8) - 8\beta(3\gamma-2)};\quad q_2^M = \frac{3\gamma(3\gamma-4\beta)(a-c)}{3\gamma(9\gamma-8) - 8\beta(3\gamma-2)}$$

$$\Pi_m^M = \frac{(9\gamma-8\beta^2)(3\gamma-4)^2\gamma(a-c)^2}{[3\gamma(9\gamma-8) - 8\beta(3\gamma-2)]^2};\quad \Pi_2^M = \frac{(3\gamma-4\beta)^2\gamma(9\gamma-8)(a-c)^2}{[3\gamma(9\gamma-8) - 8\beta(3\gamma-2)]^2}$$

A4. Proof of Proposition 2

Participation conditions

Given the R&D investments vector $X^M = \left[x_1^M \;\; x_2^M \;\; 0\right]$, the firm 1 receives a share β of the merged firm's gross profits $\pi_m^M(x_1^M,\, x_2^M) = \left[q_m^M\left(x_1^M,\; x_2^M\right)\right]^2$. Thus, firm 1 receives:

$$\pi_1^M(x_1^M, x_2^M) = \frac{\beta(9\gamma - 8\beta)\,(3\gamma - 4)^2\,\gamma\,(a-c)^2}{[3\gamma(9\gamma - 8) - 8\beta(3\gamma - 2)]^2}$$

Given X^M, if the firm 1 deviates from the *merger* equilibrium towards the *no-integration* one, the standing-alone gross profits that it earns are given by $\pi_1^N(x_1^M, x_2^M, 0) = \left[q_1^N(x_1^M, x_2^M, 0)\right]^2$. Thus, firm 1 receives:

$$\pi_1^N(x_1^M, x_2^M, 0) = \frac{(3\gamma - 4)^2\,(4\beta + 9\gamma)^2\,(a-c)^2}{16[3\gamma(9\gamma - 8) - 8\beta(3\gamma - 2)]^2}$$

The firm 1 has incentives for merger if $\pi_1^M(x_1^M, x_2^M) > \pi_1^N(x_1^M, x_2^M, 0)$, a condition that holds if $\beta > \widehat{\beta}_1(\gamma) = \frac{9}{4}(2\gamma^2 - \gamma - 2\sqrt{\gamma^4 - \gamma^3})$.

In the same lines, the firm 3 receives a share $1-\beta$ of the merged firm's gross profits, i.e., $\pi_3^M(x_1^M, x_2^M) = (1-\beta)\;\pi_m^M(x_1^M,\, x_2^M) = (1-\beta)\left[q_m^M\left(x_1^M,\; x_2^M\right)\right]^2$. Thus, firm 3 receives:

$$\pi_3^M(x_1^M, x_2^M) = \frac{9(1-\beta)\gamma^2\,(3\gamma - 4)^2\,(a-c)^2}{[3\gamma(9\gamma - 8) - 8\beta(3\gamma - 2)]^2}$$

If the firm 3 deviates from the *merger* equilibrium towards the *no-integration* one, the standing-alone gross profits that it earns are given by $\pi_3^N(x_1^M,\; x_2^M, 0) = \left[q_3^N(x_1^M, x_2^M, 0)\right]^2$. Thus, firm 3 receives:

$$\pi_3^N(x_1^M, x_2^M, 0) = \frac{9\,(3\gamma - 4)^2\,(3\gamma - 4\beta)^2\,(a-c)^2}{16[3\gamma(9\gamma - 8) - 8\beta(3\gamma - 2)]^2}$$

The firm 3 has incentives for merger if $\pi_3^M(x_1^M, x_2^M) > \pi_3^N(x_1^M, x_2^M, 0)$, a condition that holds if $\beta \leq \widehat{\beta}_3(\gamma) = \frac{1}{4}(3\gamma - 2\gamma^2 + 2\sqrt{4\gamma^2 - 3\gamma^3 + \gamma^4})$.

Stability conditions

Given the R&D investments vector X^M, suppose that firms 1 and 2 deviate from the proposed merger configuration $\{1+3\}$ towards the configuration $B\{1+2\}$. Since $x_2^M > x_1^M$, the merged firm m will produce its output with the firm 2's technology, while the outside firm 3 has not invested in R&D.

If the firm 1 deviates from the proposed merger configuration $\{1+3\}$ towards the configuration $\{1+2\}$, firm 1 receives a share β of the merged firm's gross profits $\pi_m^{\{1+2\}}(x_2^M, 0) = \left[q_m^{\{1+2\}}(x_2^M, x_3^M = 0)\right]^2$. Thus, firm 1 receives:

$$\pi_1^{\{1+2\}}(x_2^M, 0) = \frac{\beta[27\gamma^2 - 8\beta(2+3\gamma)]^2 (a-c)^2}{9[3\gamma(8-9\gamma) + 8\beta(3\gamma-2)]^2}$$

It can be checked that the firm 1 has no incentives for deviation from $\{1+3\}$ towards $\{1+2\}$ as long as $\pi_1^{\{1+2\}}(x_2^M, 0) < \pi_1^{\{1+3\}}(x_m^M, x_2^M)$ always holds.

In the same lines, if the firm 2 deviates from $\{1+3\}$ to $\{1+2\}$, it receives $\pi_2^{\{1+2\}}(x_2^M, 0) = (1-\beta)\ \pi_m^{\{1+2\}}(x_2^M, 0) = (1-\beta)\left[q_m^{\{1+2\}}(x_2^M, 0)\right]^2$. Thus, firm 2 receives:

$$\pi_2^{\{1+2\}}(x_2^M, 0) = \frac{(1-\beta)[27\gamma^2 - 8\beta(2+3\gamma)]^2 (a-c)^2}{9[3\gamma(8-9\gamma) + 8\beta(3\gamma-2)]^2}$$

It can be checked that the firm 2 has no incentives for deviation from $\{1+3\}$ towards $\{1+2\}$ as long as $\pi_2^{\{1+2\}}(x_2^M, 0) < \pi_2^{\{1+3\}}(x_1^M, x_2^M)$ always holds.

In the same lines, it is also proved that firms 2 and 3 have not incentives for deviation from $\{1+3\}$ towards $\{2+3\}$.

A5. Total welfare for each candidate equilibrium

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

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

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

References

Banal-Estañol, A., Macho-Stadler, I., Seldeslachts, Jo, 2008. Endogenous mergers and endogenous efficiency gains: The efficiency defence revisited. International Journal of Industrial Organization 26, 69-91.

Barros, P.P., 1998. Endogenous mergers and size asymmetry of merger participants. Economics Letters 60, 113-119.

Binmore, K., Rubinstein, A., Wolinsky, A., 1986. The Nash bargaining solution in economic modelling. Rand Journal of Economics 17, 176–188.

Canoy, M., Riyanto, Y.E., Van Cayseele, P., 2000. Corporate takeovers, bargaining and managers' incentives to invest. Managerial and Decision Economics 21, 1-18.

Cramton, P., 1998. Auctions and takeovers. In: Newman, P.New Palgrave Dictionary of Law and Economics Vol. 1. Macmillan, London, pp. 122–125.

d'Aspremont, C., Jacquemin, A., 1988. Cooperative and non-cooperative R&D in duopoly with spillovers. American Economic Review 78, 1133-1137.

Davidson, C., Ferrett, B., 2007. Mergers in Multidimensional Competition. Economica 74, 695–712.

Deneckere, R., Davidson, C., 1985. Incentives to form coalitions with Bertrand competition. Rand Journal of Economics 16, 473-486.

Farrell, J., Shapiro, C., 1990. Horizontal mergers: an equilibrium analysis. American Economic Review 80, 107-126.

Faccio, M., Masulis R.W., 2005. The choice of payment method in European mergers and acquisitions. The Journal of Finance 60(3), 1345-1388.

Gonzàlez-Maestre M., López-Cuñat, J., 2001. Delegation and mergers in oligopoly. International Journal of Industrial Organization 19, 1263–1279.

Gugler, K., Mueller D.C., Yurtoglu, B.B., Zulehner, C., 2003. The effects of mergers: an international comparison. International Journal of Industrial Organization 21, 625-653.

Horn, H. and L. Persson, 2001. Endogenous mergers in concentrated markets. International Journal of Industrial Organization 19, 1213-1244.

Inderst, R., Wey, Ch., 2004. The incentives for takeover in oligopoly. International Journal of Industrial Organization 22, 1067-1089.

Kamien, M.I., Zang, I., 1990. The limits of monopolization through acquisition. Quarterly Journal of Economics 105(2), 465–499.

Katsoulacos, Y., Ulph, D., 1998. Endogenous spillovers and the performance of research joint ventures. The Journal of Industrial Economics 46, 333-357.

Lommerud, K.E., Sorgard, L., 1997. Merger and product range rivalry. International Journal of Industrial Organization 16, 21-42.

Lommerud, K.E., Straume O.R., Sorgard, L., 2005. Downstream merger with upstream market power. European Economic Review 49, 717-743

Lommerud, K.E., Straume O.R., Sorgard, L., 2006. National versus international mergers in unionised oligopoly. Rand Journal of Economics 37, 212-233.

Motta, M., Vasconcelos, H., 2005. Efficiency gains and myopic antitrust authority in a dynamic merger game. International Journal of Industrial Organization 23, 777– 801.

Neven, D.J., Röller, L.H. 2005. Consumer surplus vs. welfare standard in a political economy model of merger control. International Journal of Industrial Organization 23, 829–848.

Perry, M.K., Porter, R.H., 1985. Oligopoly and the incentives for horizontal merger. American Economic Review 75, 219-227.

Röller, L.H., Stennek, J., Verboven, F., 2001. Efficiency gains from mergers, In: The Efficiency Defence and the European System of Merger Control, Reports and Studies of the Directorate for Economic and Financial Affairs Vol. 5.

Salant, S., Switzer, S., Reynolds, R.J., 1983. Losses from horizontal merger: the effects of an exogenous change in industry structure on Cournot-Nash equilibrium. Quarterly Journal of Economics 98, 185-199.

Socorro, M.P., 2004. R&D investment as a signal in corporate takeovers. Facultat de Ciencias Economicas de la ULPGC, Documentos de trabajo conjucto 2004-07.

Stenbacka, L.R., 1991. Mergers and investments in cost reduction with private information. International Journal of Industrial Organization 9, 397-405.

Stigler, G.J., 1950. Monopoly and oligopoly by merger. American Economic Review, Papers and Proceedings 40, 23-34.

Straume, O.R., 2006. Managerial delegation and merger incentives with asymmetric costs.

Journal of Institutional and Theoretical Economics 162, 450-469.

UNCTAD. World Investment Report 2000: Crossborder Mergers and Acquisitions and Development. New York and Geneva: United Nations.

UNCTAD. World Investment Report 2000: Transnational Corporations, Extractive Industries and Development. New York and Geneva: United Nations.

Williamson, O.E., 1968. Economies as an antitrust defence: the welfare trade-offs. American Economic Review 58, 18-36.

Wong, K.P., Tse, M.K.S., 1997. Mergers and investments in cost reduction with private information revisited. International Journal of Industrial Organization 15, 629-634.

Ziss, S., 2001. Horizontal mergers and delegation. International Journal of Industrial Organization 19, 471–492.Vonortas, N.S. (1997), "Research joint ventures in the United States", *Research Policy,* 26, 577-595.