Ex post merger evaluations and strategic premerger investments*

Richard Friberg, Stockholm School of Economics and CEPR
Pehr-Johan Norbäck, Research Institute of Industrial Economics
Lars Persson, Research Institute of Industrial Economics and CEPR

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Abstract

We present a model that warns against a mechanical comparison of pre- and postmerger prices. The starting point of the paper is that both the seller and the buyer take into account how the *acquisition price* is affected by premerger investments. We derive conditions under which the selling of a firm triggers overinvestment by both the acquirer and the target. Under Cournot competition, linear demand, and quadratic investment costs, we show that these incentives to overinvest can lead to a lower price in a post-acquisition duopoly than in an ongoing triopoly.

JEL codes: L13, L40, L66

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1. Introduction

> "Selling a company is like going "all in" in a game of poker. It is a single final decision that will irrevocably determine the value of the investment for shareholders. The stakes could not be higher to maximize the value of a deal."
> Michael S. Frankel, "Mergers and Acquisitions Basics" (2005), p. 108.

There is a dearth of ex post evaluations of the price effects of mergers (see for instance Angrist and Pischke (2010), Ashenfelter and Hosken (2008), Carlton (2009) and Nevo and Whinston (2010)). Given the importance of mergers and acquisitions in the economy, and the crucial role for merger policy, we are likely to see a large number of such studies in the coming years. One way of performing ex post evaluations is to use the tool kit that has become the standard in labor economics such as difference-in-difference techniques. Focarelli and Panetta (2003), Hastings (2004) and Kim and Singhal (1993) are examples of such studies of mergers. A typical study would use a pre-merger period as the benchmark and evaluate the price effect on the "treated" products. Kim and Singhal (1993), for instance, examine prices of air transport in the quarter before the merger announcement and prices in the quarter after the completion.

In this paper, we examine how prices and investments are affected by an upcoming merger. We consider an oligopoly where an acquirer and a target have possibilities of investing in a first stage. In a subsequent stage, alternative buyers compete to acquire the target firm.[1] The target firm invests to maximize the acquisition price, net investment costs. The acquirer invests to maximize the product market profits – net investment costs and the acquisition price. Taking the effects of investment on the acquisition price into account generates strikingly different predictions from static oligopoly. We consider a standard setting with linear demand, quantity competition, homogenous goods and quadratic investment costs. We show that if investment costs are moderately convex, the price in a duopoly with strategic investment is lower than the price in a static triopoly. Our analysis thus emphasizes that one should be very careful before accepting prices right before a merger as reflecting a long-run equilibrium.

Our parametric model shows that strategic overinvestment effects can be quantitatively important. To explore how the results generalize beyond the specific functional forms chosen, we analyze a more general case using slopes of reaction functions in Section 4. The main assumption that drives the results is that an investment increases the product market profits for the investing firm and decreases the product market profits for other firms. In the words of Fudenberg and Tirole (1984) we thus assume that investments make a firm "tough". The intuition for our results is plain. In the main case that we analyze, the target has an incentive to overinvest from the perspective of the acquirer. The

[1] Boone and Mulherin (2007) document that the typical sale of a firm features several bidders.

acquirer would like the target to choose the investment level that maximizes the profits of the combined firm. In contrast, the target only takes into account how the *acquisition price* is affected. In equilibrium, the acquisition price is shown to equal the alternative acquirer's valuation of obtaining the target. Investments increase the acquisition price by not only generating an increase in the acquirer's profit, but also through the negative impact on the non-acquirer's profit. The *target* thus has an incentive to overinvest.

We also show that the *acquirer* has an incentive to overinvest. By increasing competition in the product market, the acquirer's investment decreases the alternative acquirer's value of obtaining the target, which reduces the acquisition price. Taken together, these incentives to overinvest prior to the acquisition will lead to higher equilibrium investments in the market than if strategic motives are not present.

The theoretical literature on mergers has paid little attention to the interaction of investments and mergers over time.[2] A small set of papers theoretically examines the evolution of industry investment over time and allows for mergers or takeovers. Pesendorfer (2005), for instance, shows that a merger today may become profitable by triggering future mergers. He uses exogenous merger criteria and the acquisition price is thus not determined in the model. Using numerical methods, Gowrisankaran (1999)[3] models the evolution of an industry allowing for entry, exit and investments as well as mergers. He uses a setting with a dominant firm and a competitive fringe that are price takers both in the capital and the product market. Consequently, the strategic effects on which we focus in our study are abstracted from in those studies.[4]

A precursor lies in work focusing on predatory pricing before a takeover to improve the terms of the deal (see Yamey (1972) for informal discussions or Burns (1986) for empirical evidence on this type of behavior by American Tobacco Co). A formalization of a similar outcome is Saloner (1987)[5] who shows that in a signaling model, a duopolist might want to expand output to signal that it is a low-cost firm and thereby improve the terms of the takeover. However, in these studies, the seller cannot invest which is

[2] A large set of papers (see, for instance, Salant et al. (1983), Perry and Porter (1985), Deneckere and Davidson (1985) or Farrell and Shapiro (1990)) clarifies how mergers affect prices, profits and welfare, depending on the market structure in various static oligopoly models. Such papers are sometimes referred to as the exogenous merger literature – the firms that merge are exogenously chosen. They are silent on the terms of the deal and do not address the kind of strategic concerns on which we focus. Recently, a literature on endogenous mergers has emerged: Who merges with whom is a central question and there is an explicit modeling of the acquisition game (see, for instance, Horn and Persson (2001)). In this vein, Fridolfsson and Stennek (2005) show how unprofitable mergers may occur if being an outsider is even worse than being an insider. The kind of strategic behavior on which we focus is not present, however. Somewhat related is also Christou et al (2009). Their focus is on links between investments and demand uncertainty. They allow mergers in a setting with investments in a first period followed by three periods of price competition in a homogenous goods market.

[3] The model builds on Pakes and McGuire (1994).

[4] Related is also recent work by Byford and Gans (2008). In their model an efficient incumbent is a soft competitor in order not to push a less efficient incumbent to exit by selling to a more efficient potential entrant.

[5] See also Persson (2004) for a formalization in a multi-firm predation context.

possible in our setting.[6]

2. The model

We consider an oligopoly industry served by three firms, denoted by S, B and A. Firm S is the potential *seller*, firm B the potential *buyer* and firm A the *alternative* buyer. There are three stages. In a first stage, firms may invest in new capital k_i. The cost of investing is given by $C(k_i)$ with $C'(k_i) > 0$. In a second stage, firm S is up for sale with firms B and A as the potential acquirers. In a final stage, B and A compete in oligopoly, given the total capital holding of firm i, denoted K_i. The game is solved backwards.

2.1. Stage 3: product market interaction

In our main analysis, we assume that the market is a duopoly in stage 3 since firm S exits the market via a sale. In Section 3.2, we also consider an ongoing triopoly in stage 3. In the oligopoly interaction, firm i chooses an action $x_i \in R^+$ to maximize its product market profit, $\Pi_i(x_i, x_{-i}, K_i, K_{-i})$ which depends on its own and its rivals' market actions, x_i and x_{-i}, as well as the total amount of capital holdings by firm i, K_i, and on the capital of rivals K_{-i}. Action, x_i, can be a price or a quantity. Assume that there exists a unique and stable Nash-Equilibrium in actions, $x_i(K_i, K_{-i})$, defined from the first-order conditions[7]:

$$\frac{\partial \Pi_i(x_i, x_{-i}; K_i, K_{-i})}{\partial x_i} = 0. \tag{2.1}$$

From (2.1), define $R_i(K_i, K_{-i}) = \Pi_i(x_i(K_i, K_{-i}), x_{-i}(K_i, K_{-i}), K_i)$ as a reduced-form profit for firm i.

2.2. Stage 2: The acquisition process

Let us now turn to the equilibrium ownership of firm S.[8] For expositional reasons, we normalize initial capital holdings to zero. We model the acquisition process as a perfect information auction, where firms B and A simultaneously post bids on S to acquire its assets k_S. Each firm announces a bid, b_i, where $\mathbf{b} = (b_B, b_A) \in R^2$ is the vector of these bids. The acquisition price is denoted by P. Each potential buyer faces an individual fixed cost of incorporating firm S's assets into its own operations, f_i.

[6] Moreover, it has been shown that a selling independent investor has a stronger incentive to invest than an incumbent firm, due to strategic effects on the sales price (Katz and Shapiro (1986) and Norbäck and Persson (2008)).

[7] See Dixit (1986) for an analysis of the stability condition in oligopoly models.

[8] Note that we abstract from why the seller sells its assets. One reason is that the sale is profitable due to market power and synergy effects which, in turn, will depend on the demand and cost structure in the industry. Another reason is that the seller has an outside option with a higher return and a sale is necessary to exploit this outside opportunity due to managerial or financial constraints. Moreover, Mitchell and Mulherin (1996) find that mergers are to a large extent driven by industry shocks.

We now turn to firms' valuations of acquiring firm S. Starting with B's valuation, we have:

$$v_B = R_B(k_B + k_S, k_A) - R_B(k_B, k_A + k_S) - f_B, \tag{2.2}$$

where the first term shows the profit for B when possessing the target firm S and the second term shows the profit for B if S is acquired by firm A.

Similarly, A has the following valuation:

$$v_A = R_A(k_A + k_S, k_B) - R_A(k_A, k_B + k_S) - f_A. \tag{2.3}$$

We assume that f_A is greater than f_B, and that the difference is sufficiently large to ensure that $v_B > v_A$.[9] It is then straightforward to derive the following lemma[10]:

Lemma *The target firm is acquired by firm B at a price equal to the valuation by firm A, i.e.* $P = v_A$

Proof. See the Appendix. ■

2.3. Stage 1: Optimal investment.

Let us now characterize firms' investments in stage 1 when S is to be put up for sale in stage 2.

The seller's incentive Using Lemma 1 and (2.3), firm S invests to maximize the net sales price:

$$\begin{aligned} \max_{k_S} &: P - C(k_S) \\ s.t &: P = v_A = R_A(k_A + k_S, k_B) - R_A(k_A, k_B + k_S) - f_A. \end{aligned} \tag{2.4}$$

The optimal investment for firm S is then given from the first-order condition:

$$\underbrace{\tfrac{\partial R_A(k_A + k_S, k_B)}{\partial k_S} - \tfrac{\partial R_A(k_A, k_S + k_B)}{\partial k_S}}_{\frac{\partial v_A}{\partial k_S}} = C'(k_S). \tag{2.5}$$

Already here we can see the incentive to overinvest, if A were to control S it would equate the first term in 2.5 with the marginal cost. If $\frac{\partial R_A(k_A, k_S + k_B)}{\partial k_S} < 0$, the target has an incentive to overinvest from the perspective of the acquirer. The acquirer would like the target to choose the investment level that maximizes the profits of the combined firm. In contrast, the target only takes into account how the acquisition price is affected.

[9] This will hold for all $f_A - f_B \geq 0$ in the Cournot model in section 3. It will not hold if the return to investment is sufficiently concave, since the smaller firm will then outbid the larger firm.

[10] The correct acquisition price P^* is $v_A - \varepsilon$ but, to simplify the presentation, we use v_A.

The buyer's incentives: Using Lemma 1 and (2.3), firm B solves:

$$\begin{aligned} \max_{k_B} &: \ R_B(k_B + k_S, k_A) - P - C(k_B) \\ s.t &: \ P = v_A = R_A(k_A + k_S, k_B) - R_A(k_A, k_B + k_S) - f_A. \end{aligned} \tag{2.6}$$

From (2.4), the buyer realizes that the seller will invest when exiting by a sale, $k_S > 0$. This implies $P = v_A > 0$ and the first-order condition is:

$$\frac{\partial R_B(k_B+k_S,k_A)}{\partial k_B} - \underbrace{\left[\frac{\partial R_A(k_A+k_S,k_B)}{\partial k_B} - \frac{\partial R_A(k_A,k_S+k_B)}{\partial k_B}\right]}_{\frac{\partial v_A}{\partial k_B}} = C'(k_B). \tag{2.7}$$

Once more, if there were no strategic effect, B would simply invest to equate the first term with the marginal cost. If $\frac{\partial R_A(k_A+k_S,k_B)}{\partial k_B} - \frac{\partial R_A(k_A,k_S+k_B)}{\partial k_B} < 0$, the acquirer has an incentive to overinvest. By increasing the competition in the product market, the acquirer's investment decreases the alternative acquirer's value v_A of obtaining the target which reduces the acquisition price.

The alternative buyer's incentives: Firm A solves:

$$\max_{k_A} : R_A(k_A, k_B + k_S) - C(k_A). \tag{2.8}$$

The first-order condition is:

$$\frac{\partial R_A(k_A,k_B+k_S)}{\partial k_A} = C'(k_A). \tag{2.9}$$

3. A Linear Quadratic Cournot Model

To illustrate the quantitative implications of the incentives to affect the acquisition price, we first consider an example with simple functional forms. Assume that the inverse demand curve is given by

$$p(q_A, q_B, q_S) = a - q_A - q_B - q_S \tag{3.1}$$

and that the investment costs are

$$C(k_i) = \frac{\mu k_i^2}{2}. \tag{3.2}$$

The price is p, q_i are quantities produced by firm i, μ is a constant and the other notation is as before. Furthermore, assume that the investment affects profits by reducing the marginal cost from c to $c - K_i$. Given this setup, the calculations that follow are standard and not all are detailed – full derivations are available in a downloadable appendix.[11]

3.1. Product market competition and investments when firm S is bought by B

In stage 3, from (2.1) and linear demand (3.1), the Cournot-Nash equilibrium for B and A in the duopoly market is (using a superscript D to denote duopoly):

$$q_B^D(k_B+k_S,k_A) = \tfrac{\Lambda+2(k_B+k_S)-k_A}{3}, \quad q_A^D(k_A,k_B+k_S) = \tfrac{\Lambda+2k_A-(k_B+k_S)}{3} \tag{3.3}$$

$$q_A^D(k_A+k_S,k_B) = \tfrac{\Lambda+2(k_A+k_S)-k_B}{3}, \quad q_B^D(k_B,k_A+k_S) = \tfrac{\Lambda+2k_B-(k_A+k_S)}{3}, \tag{3.4}$$

where $\Lambda = a - c$. From linear demand (3.1), it follows that reduced-form profits are quadratic in output, i.e. $R_i^D(K_i,K_{-i}) = \left[q_i^D(K_i,K_{-i})\right]^2$.In stage 2, the acquisition price P is given by Lemma 2.2.

Let us now turn to the investments in stage 1. Using (2.4), (2.6) and (2.8), in the case where there is an expected sale of firm S, the equilibrium investments are given by

$$k_S^D = \tfrac{18\mu(3\mu-4)\Lambda}{276\mu-198\mu^2+81\mu^3-64}, \; k_B^D = \tfrac{4\left(3\mu+9\mu^2+16\right)\Lambda}{276\mu-198\mu^2+81\mu^3-64}, \; k_A^D = \tfrac{4(3\mu-4)^2\Lambda}{276\mu-198\mu^2+81\mu^3-64}. \tag{3.5}$$

Note that the investment cost function must be sufficiently convex for the seller to invest in equilibrium, i.e. $276\mu - 198\mu^2 + 81\mu^3 - 64 > 0$.[12]

3.2. Product market competition and investments in an ongoing triopoly

The specific functional forms allow us to make a comparison with the case where S is not to be sold so that there is an ongoing triopoly. Using a superscript T to denote triopoly, it follows that the Cournot-Nash equilibrium is

$$q_B^T = \tfrac{\Lambda-k_A+3k_B-k_S}{4}, \quad q_A^T = \tfrac{\Lambda+3k_A-k_B-k_S}{4}, \quad q_S^T = \tfrac{\Lambda-k_A-k_B+3k_S}{4}. \tag{3.6}$$

From linear demand (3.1), it once more follows that reduced-form profits are quadratic in output, i.e. $R_i^T(K_i,K_{-i}) = \left[q_i^T(K_i,K_{-i})\right]^2$. In this case, a Nash-equilibrium when B, S and A invest to maximize profits now yields symmetric equilibrium investments, since the incentive to affect the acquisition price is mute:

$$k_B^T = k_S^T = k_A^T = \tfrac{3\Lambda}{8\mu-3}. \tag{3.7}$$

For comparison, we also consider the duopoly case where firm S exits at the beginning of stage 1 and B and A compete in the product market stage. Thus, this is a duopoly

[11] It will be available at www.hhs.se/personal/friberg

[12] This amounts to requiring that $\mu > 0.28$.

case where there is no strategic behavior to affect a sales prices. In this case, equilibrium investment is given by

$$k_B^{\widetilde{D}} = k_A^{\widetilde{D}} = \frac{4\Lambda}{9\mu - 4}. \tag{3.8}$$

3.3. A duopoly with strategic pre-sales behavior and an ongoing triopoly: A comparison

Using equilibrium investments and quantities, we can calculate prices, profits and consumer surplus in the cases discussed above. The expressions do become somewhat unwieldy and we use the graph below to illustrate our main points in this section. We relate the price to the convexity of the investment function (μ). The more convex is the cost of investment, the less investment and the higher the price.

As a benchmark, the dashed black line in Figure 3.1 shows the price in a duopoly when there is no sale. The consumer price is then given from the investments in (3.8). The solid grey line shows the price in a triopoly with no sale. The consumer price is then derived from the investments in (3.7). A comparison of these two lines shows the standard effect that a more concentrated market is associated with higher prices.

Strategic behavior will complicate an evaluation of the effect of a merger. To see this, note that the solid black line shows the price under duopoly when there is strategic investment prior to a sale. The incentives to overinvest are reflected in a lower price on the market than in a standard duopoly. Even more striking is that for low to intermediate degrees of convexity of the investment function, the price under a duopoly with strategic behavior is lower than the price under triopoly. In these cases, overinvestment is sufficient to outweigh the effect of a greater concentration on price. The starkest illustration of a fall in the price as a result of investment is provided if we compare the price when there is a triopoly but the investment levels are those associated with strategic behavior to affect the sales price (the dashed grey line). Note that this lowest level is likely to provide the most accurate description of the price in the stages just before a merger.

In terms of the time series pattern of prices surrounding a merger, the logic of this section would imply that the price falls from the solid grey line to the dashed grey line as an effect of investments to affect the sales price. As the merging parties agree, they are likely to start acting as a joint profit maximizer and the price jumps to the black solid line. Consequently, we can state the following result:

Proposition 1. *In the linear quadratic Cournot model with moderately convex investment costs the consumer price is lower, in a duopoly with strategic investments, than it is in an ongoing triopoly.*

If we are interested in really long-run effects of the merger (absent entry), when the investments have fully depreciated, the comparison between the uppermost line and the

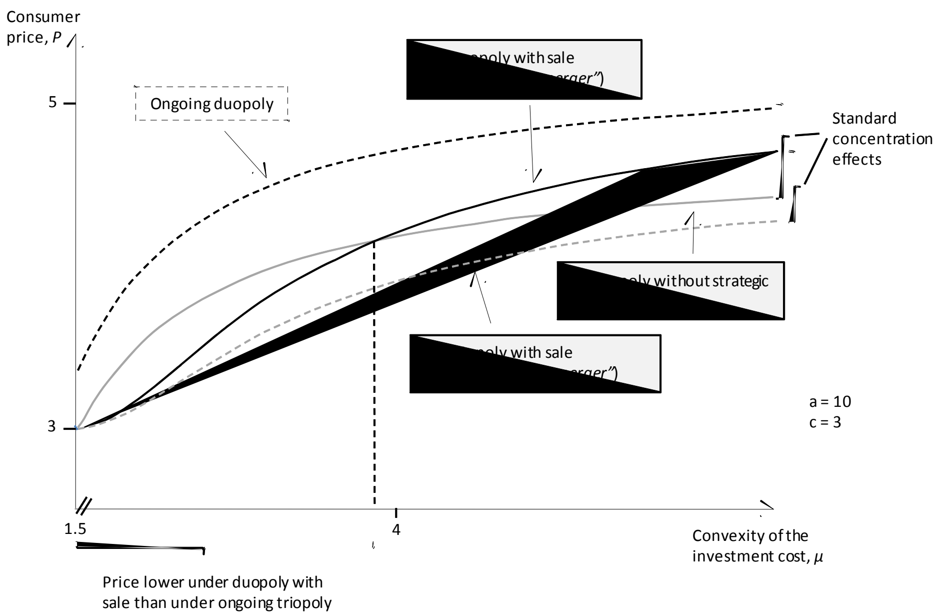

Figure 3.1: Consumer price in the product market under various market structures.

solid grey line is clearly the relevant one. The most severe misrepresentation of the merger will result if we only consider a short time window before the merger and a very long one afterwards – we would then compare the lowest dashed line to the uppermost line.

4. When do mergers lead to strategic premerger investments?

We now consider the same setting as above but refrain from making any assumptions on functional forms. We are motivated by understanding what assumptions we need to make to generate the incentives for strategical investment pre-acquisition in equilibrium.

Assume that the cost of investing is given by $C(k_i)$ with $C'(k_i) > 0$. For expositional reasons, we will assume that the alternative buyer does not invest, $k_A = 0$. To unambiguously establish that equilibrium investments with strategic investment are greater than those without strategic investment, we need to make four assumptions:

Assumption A1 (i) $\frac{\partial R_i(K_i,K_{-i})}{\partial K_i} > 0$, (ii) $\frac{\partial R_i(K_i,K_{-i})}{\partial K_{-i}} < 0$.

Assumption A2 $\frac{\partial v_A}{\partial k_B} = \frac{\partial R_A(k_S,k_B)}{\partial k_B} - \frac{\partial R_A(0,k_S+k_B)}{\partial k_B} < 0$.

Assumption A3 $\frac{\partial}{\partial k_B}\left(\frac{\partial v_A}{\partial k_S}\right) < 0$.

Assumption A4 $\frac{\partial}{\partial k_S}\left[\frac{\partial R_B(k_B+k_S,0)}{\partial k_B} - \frac{\partial v_A}{\partial k_B}\right] > 0$.

The main assumption here is A1. Profits are increasing in own investments and decreasing in rival investments. As noted in the introduction, this is what Fudenberg and Tirole (1984) denote as investments that make a firm "tough". Assumptions A2-A4 are closely related to A1 and they are discussed in context below. Stage 3 and stage 2 were described in a general way in Section 2 which allows the exposition to proceed directly to stage 1. Finally, we should note that Assumptions A1-A4 are all fulfilled in the Cournot model with endogenous investments presented in Section 3.

4.1. Stage 1: Optimal investment.

Let us now characterize firms' investments in stage 1 when firm S is to be put up for sale in stage 2. By limiting the set of buyers to firms A and B, we implicitly assume that the assets are industry specific, i.e. the assets are likely to be designed to fit the production in a particular industry and the cost of restructuring them into suitable assets in other industries is assumed to be high.[13] If the assets were not industry specific, the strategic mechanisms identified below would not be present since the buyer would then resell the assets at their "cost value".

To illustrate how subsequent mergers lead to strategic premerger investments we use a benchmark: the case where firm S leaves the market without investing $k_S = 0$. In this benchmark, the investments by firm B are obtained by setting the marginal revenue of investing equal to the marginal cost:

$$\frac{\partial R_B(k_B,0)}{\partial k_B} = C'(k_B). \tag{4.1}$$

The investment level in the benchmark is denoted $k^0 = k_B(0)$ and shown in B^0 in Figure 4.1(i).

Now, let us turn to strategic premerger investments.

The seller's incentive As previously, the seller will maximize the net sales price (with k_A set to 0 for simplicity):

$$\begin{aligned} \max_{k_S} \quad &: \quad P - C(k_S) \\ s.t \quad &: \quad P = v_A = R_A(k_S, k_B) - R_A(0, k_B + k_S) - f_A. \end{aligned} \tag{4.2}$$

To ensure that there is an interior solution to this problem, we assume that $v_A - C(k_S)$ is strictly concave in k_S. The optimal investment for firm S is given from the first-order condition:

$$\underbrace{\frac{\partial R_A(k_S,k_B)}{\partial k_S} - \frac{\partial R_A(0,k_S+k_B)}{\partial k_S}}_{\frac{\partial v_A}{\partial k_S}} = C'(k_S). \tag{4.3}$$

[13] To our knowledge, the only empirical paper studying the sector specificity of assets is that of Ramey and Shapiro (2001), which finds capital to be very specialized by sector.

From Assumption A1, we have $\frac{\partial R_A(k_S,k_B)}{\partial k_S} > 0$. In particular, note that $\frac{\partial R_A(0,k_B+k_S)}{\partial k_S} < 0$. This implies that the seller has an incentive to overinvest. Note that this is an incentive to overinvest not only with respect to the case where the seller would exit without a sale and set $k_S = 0$. It is also an overinvestment relative to the investment level that would maximize A's profit if A were in control (in which case A would equate the first term to the marginal cost of investing). The choice for S is illustrated in S^0 in Figure 4.1(ii), where $k_S^0(0) > k^0$ is the optimal investment by firm S if firm B does not invest.

The buyer's incentives: As before, firm B solves:

$$\begin{aligned} \max_{k_B} &: R_B(k_B + k_S, 0) - P - C(k_B) \\ s.t &: P = v_A = R_A(k_S, k_B) - R_A(0, k_B + k_S) - f_A, \end{aligned} \tag{4.4}$$

where we assume that $R_B(k_B + k_S, 0) - v_A - C(k_B)$ is strictly concave in k_B.

From (4.3), the buyer should realize that the seller will invest when exiting by a sale, $k_S > 0$. Since this implies $P = v_A > 0$, the first-order condition is:

$$\frac{\partial R_B(k_B+k_S,0)}{\partial k_B} - \underbrace{\left[\frac{\partial R_A(k_S,k_B)}{\partial k_B} - \frac{\partial R_A(0,k_S+k_B)}{\partial k_B}\right]}_{\frac{\partial v_A}{\partial k_B}} = C'(k_B). \tag{4.5}$$

The first term in (4.5) is positive from Assumption A1. To evaluate the second term in (4.5), we use A2 which posits that the negative impact of B's investment is larger for A when B possesses S's assets. Since the derivatives are evaluated at different asset levels for A, we cannot use A1 to sign this difference but the assumptions bear a clear relation. Using Assumptions A1 and A2 in (4.5), it follows that also the buyer has an incentive to overinvest.

Let us now determine the buyer's and seller's equilibrium investments.

Equilibrium investments Suppose that B believes that S will choose $k_S^0 > 0$. Firm B will then choose $\tilde{k}_B(k_S^0)$, which is given by the intersection of the marginal revenue of investing evaluated at the seller's investment level k_S^0 and the marginal cost $C'(k_B)$. Since a higher investment reduces the acquisition price $\frac{\partial R_A(k_S^0,k_B)}{\partial k_B} - \frac{\partial R_A(0,k_S^0+k_B)}{\partial k_B} < 0$, firm B will overinvest in a comparison with the benchmark case, i.e. $\tilde{k}_B(k_S^0) > k^0$. This is illustrated in $\tilde{B}$ in Figure 4.1(i).

How will the seller react? We here make use of assumption A3, which states that firms' investments are strategic substitutes in A's valuation, v_A (equal to the acquisition price P). In other words, the marginal value for firm S of investing is lower when B increases its investment. As shown in Figure 4.1(ii), when B increases its investments from $k_B = 0$ to $k_B = \tilde{k}_B$, this shifts down the sellers marginal value of investing to

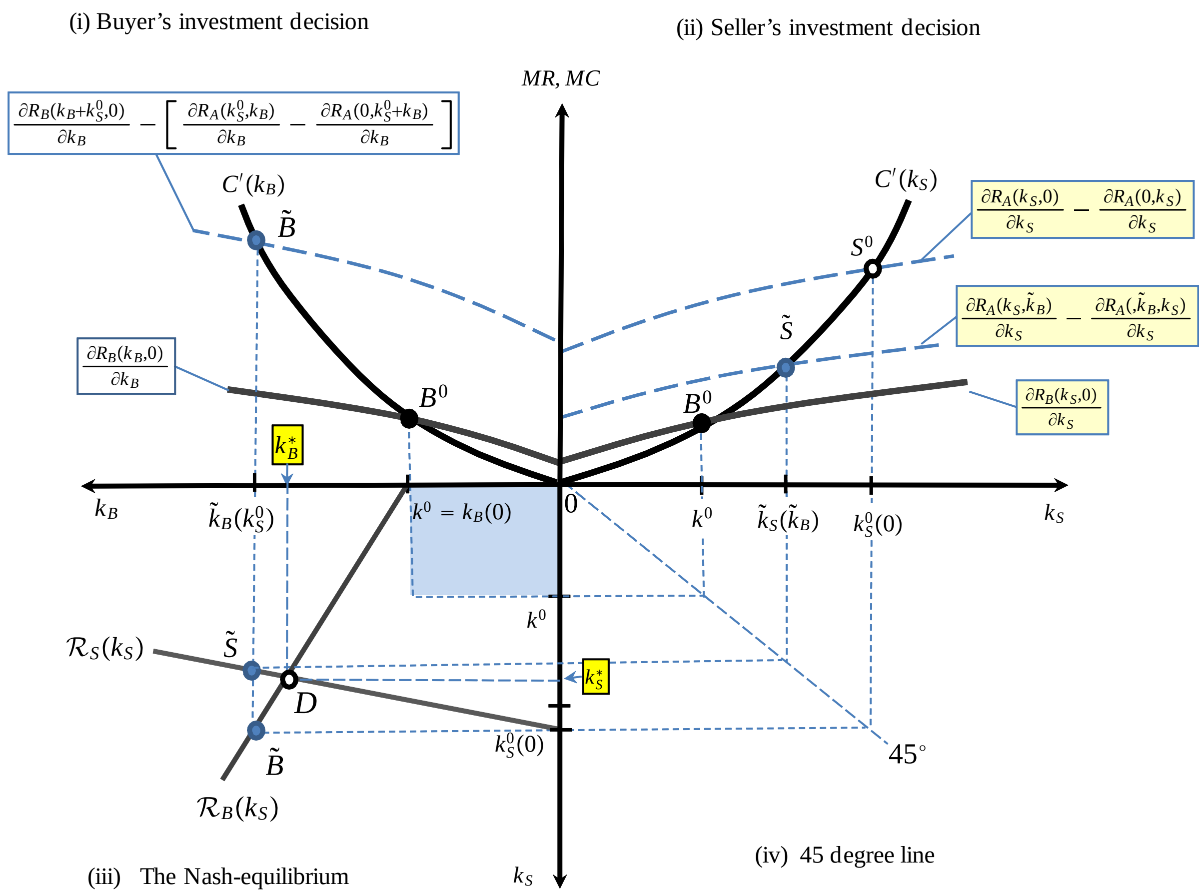

Figure 4.1: Solving for the equilibrium investments by the buyer and the seller. New-fig-all

$\frac{\partial R_A(k_S,\tilde{k}_B)}{\partial k_S} - \frac{\partial R_A(0,k_S+\tilde{k}_B)}{\partial k_S} < \frac{\partial R_A(k_S,0)}{\partial k_S} - \frac{\partial R_A(0,k_S)}{\partial k_S}$. The seller then reduces its investment to $\tilde{k}_S(\tilde{k}_B) < k_S^0(0)$. This is illustrated in $\tilde{S}$ in Figure 4.1(ii).

To determine equilibrium investments, we draw firms' reaction functions, R. These are shown in Figure 4.1(iii). Start with the seller's reaction function, $R_S(k_S)$. We know from Figure 4.1(ii) that S will invest $k_S^0(0)$ when B does not invest, whereas S will invest $\tilde{k}_S(\tilde{k}_B) < k_S^0(0)$ when B invests $\tilde{k}_B > 0$. Connecting these two points in the $k_S - k_B$ space of Figure 4.1(iv), we obtain the seller's reaction function which shows that investments are strategic substitutes in the acquisition price: the seller will reduce her investment when the buyer increases her investment.

The slope of the seller's reaction function can also be shown formally by totally differentiating the first-order condition (4.3) and rewriting it to arrive at the slope of the seller's reaction function labeled $R_S(k_S)$, as:

$$\mathcal{R}_S'(k_S) = -\frac{\frac{\partial^2 (v_A - C)}{\partial k_S}}{\frac{\partial^2 v_A}{\partial k_B \partial k_S}}. \tag{4.6}$$

Note that the denominator is negative from Assumption A3 and the nominator is negative from the assumption that $v_A - C(k_S)$ is strictly concave in k_S. Hence, we have $R'_S(k_S) < 0$ as shown in Figure 4.1(iii).

Now, turn to the buyer's reaction function, $R_B(k_S)$. From Figure 4.1(i) we know that it is optimal for B to invest k^0 when B believes that S will not invest, $k_S = 0$. Moreover, we know that B will set $\tilde{k}_B(k_S^0) > k^0$ when S sets k_S^0. Hence, we can draw B's reaction function connecting the points in $k^0 = k_B(0)$ and $\tilde{k}_B(k_S^0)$ making use of 45 degree line in Figure 4.1(iii). Then, as shown in Figure 4.1(iv), we note that optimal investments by B increase with the investments made by S, thus reflecting the increasing incentives of the buyer to overinvest in order to lower the acquisition price.

To formally derive the slope of the buyer's reaction function, we can differentiate (4.5) and rewrite to arrive at the slope of the buyer's reaction function, labeled $R_B(k_S)$:

$$\mathcal{R}'_B(k_S) = -\frac{\frac{\partial^2 R(k_B+k_S,0)}{\partial k_S \partial k_B} - \frac{\partial^2 v_A}{\partial k_S \partial k_B}}{\frac{\partial^2}{\partial k_B^2}[R_B(k_B+k_S,0) - v_A - C(k_B)]} > 0. \tag{4.7}$$

The denominator is negative from the second-order condition for profit maximization. It follows that the slope of the buyer's reaction function $R'_B(k_S)$ hinges on the sign of cross-derivatives of the profit function and here, it is the cross-derivative with respect to the profit of the buyer $R_B(k_B + k_S, 0) - C(k_B)$ net the acquisition price v_A. The second term in the numerator of (4.7) is signed by A3, i.e. that investments are strategic substitutes in the acquisition price. To sign (4.7), we then use Assumption A4 which states that the first term in the numerator, i.e. the marginal value of investing for B, may not decrease too much in S's investments. Complementarities between investments by firms B and S would, for instance, make this first term positive. Assumption A4 then ensures that $R'_B(k_S) > 0$, as shown in Figure 4.1(iii).

We can now infer the effects on investments when firm S exits the market through a sale of its assets, indicated at point D. As illustrated in Figure 4.1(iii), we have the following result:

Proposition 2. *Assume that Assumption A1-A4 hold. Then the seller always invests when exiting the market, $k_S^* > 0$ and the seller overinvest as compared to a situation where the seller would exit without a sale, $k_B^* > k^0$. Thus, in equilibrium, both the seller and the buyer overinvest.*

Thus, we have shown the main result of our paper. Having one firm put up for sale changes the investment decisions by firms in the industry. Under the case considered, there will be overinvestment from the viewpoint of the buyer in order to mitigate the incentive for overinvestment by a seller maximizing the acquisition price.

We are not aware of any broad evidence of the effect of investment on rivals' profits. The empirical literature on entry deterrence documents a number of industries where investment has a negative effect on rivals' profits and therefore, this is the case we focused on above (see, for instance, Lieberman (1987) for an early study of 38 chemical industries or Conlin and Kadiyali (2006)). If we had instead reversed assumptions A1-A4 we would have had underinvestment in equilibrium. That is, if we assume that $\frac{\partial R_A(0,k_B+k_S)}{\partial k_S} > 0$, $\frac{\partial P}{\partial k_B} > 0$, $\frac{\partial P}{\partial k_B \partial k_S} > 0$ and $\frac{\partial^2 R_B(k_B+k_S,0)}{\partial k_B \partial k_S} - \frac{\partial^2 P}{\partial k_B \partial k_S} < 0$. Like in the Fudenberg and Tirole taxonomy of business strategies, we could also consider other combinations of soft/tough and substitute/complements. Then we would not get any unambiguous results on the impact on aggregate investments.

5. Conclusions

In this paper, we show that firms involved in transfers of corporate assets have incentives to strategically invest prior to the assets transfer if investments have an impact on rivals' profits. Despite the fact that they will later buy the assets, buyers have an incentive to overinvest to strategically reduce the acquisition price. Sellers have an incentive to overinvest to strategically increase the sales price. These incentives can be sufficiently strong to reduce the price of a duopoly with strategic investments below the price of a triopoly without strategic investment. These findings have implications for the interpretation of empirical work on mergers and takeovers, and merger policy evaluation.

The period before the announcement of a merger or an acquisition is likely to be severely affected by the intention to get the best possible deal. This paper examines the idea that firms which are about to merge have incentives to let this affect their investment behavior – which, in turn, will affect product market competition. An implication for empirical work is that one should be careful in determining the pre-acquisition benchmark. Using a long time period before the merger and using finely defined time dummies can be one partial cure. There is also reason to expect the strategic motives we consider to be less pronounced in some cases. For instance, if ownership is widely dispersed, then owners are likely to be less effective in affecting strategy in order to maximize the sales price. It may also be of interest to study operations that are part of the merger but peripheral to the main businesses of the merging firms.[14]

The identified strategic overinvestment incentive for the seller and the buyer indicates that there is no a priori reason to have general policies trying to prevent such strategic investments. However, if there are no competing bidders, the strategic overinvestment incentives are absent. Consequently, ensuring bidding competition over the selling firm

[14] Fridolfsson and Stennek (2005) point out that if an efficient stockmarket anticipates the acquisition, the new information in the acquisition announcement is which firms are insiders and which are outsiders. Under this assumption, they show that preemptive mergers could explain the empirical evidence that mergers reduce profits and raise share prices. Using the same approach, Fridolfsson and Stennek (2000) show the limits of using effects on rivals' share prices to determine the competitive effect of a merger.

is crucial for generating a higher consumer surplus. Having policies which give many potential buyers the opportunity to participate in the acquisition market therefore seems warranted from a consumer surplus perspective.

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6. Appendix:

Proof of Lemma 1

Let $v_i > v_j$ without loss of generality. First, consider the equilibrium candidate where firm i acquires the seller's assets. Consider equilibrium candidate b^*, where $b_i^* > b_j^*$, $j \neq i$. Let owner i be the owner obtaining the seller's assets. Note that $b_i^* > v_i$ is a weakly dominated strategy, since no owner will post a bid over its maximum valuation of obtaining the assets. If $b_i^* < v_j$, firm j benefits from deviating to $b_j^{**} = b_i^* + \varepsilon$, since it then obtains the assets and pays a price for the assets which is lower than its valuation of obtaining them. Last, consider candidate $b_i^* = v_j$, $b_j^* = v_j - \varepsilon$. Then, no owner has an incentive to deviate. Thus, this is a Nash equilibrium and the only NE where firm i obtains the assets.

Let us now show that this is the only Nash equilibrium. First, consider the situation where firm j obtains the assets. Consider equilibrium candidate b^*, where $b_j^* > b_i^*$, $j \neq i$. But we know that in equilibrium, $b_j^* < v_j$, since firm j otherwise plays a weakly dominated strategy. But if $b_j^* < v_j$, firm i benefits from deviating to $b_i^{**} = b_j^* + \varepsilon$, since it then obtains the assets and pays a price lower than its valuation of obtaining them. Thus, firm j obtaining the assets is not an equilibrium.

Second, note that the situation where neither firm i nor firm j obtains the assets cannot occur if there is no reservation price at the auction. ■