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# Profitable horizontal mergers: A market structure-oriented view\*

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## Abstract

We propose a model in which mergers exert a more pronounced effect on the structure of a market than simply reducing the number of competitors. We show that this may render horizontal mergers profitable and welfare-improving even if costs are linear. The results help to reconcile theory with various empirical findings on mergers.

## 1 Introduction

In Cournot markets mergers are thought to affect market structure in a very simple way: The only difference between the pre-merger and the post-merger market is that the number of firms, i.e., the number of strategic players, is reduced. This has a number of important implications:

- Bilateral mergers are only profitable if costs are sufficiently convex (Perry and Porter 1985).
- Mergers of many firms into one are more likely to occur than bilateral mergers (Salant, Switzer, and Reynolds 1983, Gaudet and Salant 1991).
- Competitors benefit if other firms merge.

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- Mergers are only welfare-improving if firms are asymmetric and output is shifted from less to more efficient firms (Farrell and Shapiro 1990).

A corollary to this is that bilateral mergers in *linear* markets are never profitable and always welfare-reducing. These predictions<sup>1</sup> seem to be at odds with various empirical observations:

- (Bilateral) mergers are observed in all industries, even in those where costs are unlikely to be convex.
- In many industries bilateral mergers are more frequent than bigger multilateral mergers.
- Competitors often suffer when other firms merge (see, for example, Banerjee and Eckard 1998).
- There is no overwhelming evidence for welfare reductions as a consequence of mergers, welfare changes go in both directions (see, for example, Federal Trade Commission 1999).

In this note we consider the internal structure of firms and show that merger may generate a firm structure in Cournot markets which reverses all major predictions of the standard models. We find that bilateral mergers can be profitable and welfare-improving in linear markets, while the profits of competitors of merging firms are reduced. Also, we find that there is an upper bound on the number of firms which can be involved in a profitable merger.

The key difference between our approach and the established ones is that we take into account the fact that when two firms merge they are kept as separately managed units, governed by a newly created joint headquarter. This organizational form (“multilayered subsidiary”) has been shown to be common in merged firms (Prechel, Boies, and Woods 1999). We show that joint headquarters can govern its affiliates such that merging becomes profitable. Two properties are key to this result. First, information about production and output decisions flows more freely and more quickly among the

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<sup>1</sup>As shown by Deneckere and Davidson (1985), in Bertrand markets some predictions of the merger literature are more in line with empirical observations. For instance, in Bertrand markets, merger is profitable, even if only two firms merge. However, competitors benefit if other firms merge and merger reduces consumer welfare. This is still at odds with empirical evidence.

two merged firms than between other firms. Second, the headquarter may impose a timing rule for the decisions.

Innocent as these properties may seem, they have a profound impact on the market post merger as a whole. In fact, we will show that the two properties generate a commitment advantage for the merged firms.

If it is commonly known that two firms have merged in this manner, the market will no longer be a simple Cournot market. Rather, there will be a “partial Stackelberg leader” and a “partial Stackelberg follower” (the two units of the merged firm) and  $n - 2$  “Cournot firms.” Analyzing this market we arrive at the above mentioned main conclusions: mergers can be profitable and welfare-improving even if all firms have the same linear cost functions. At the same time competitors’ profits are reduced.

The remainder of the paper is organized as follows: In Section 2 we present the basic linear model and derive our main results. Section 3 presents two extensions. In the first one we study how many bilateral mergers are profitable in a market and in the second one we deal with the question of how many firms can profitably merge into one. Finally, Section 4 summarizes and discusses our results.

## 2 The basic model

Consider a market for a homogenous product with linear demand and cost and  $n$  symmetric firms. We can normalize price and unit such that inverse demand can be written as  $p(X) = \max\{1 - X, 0\}$  with  $X = \sum_{i=1}^n x_i$  denoting total supply and  $x_i$  firm  $i$ ’s individual quantity. Supply quantities are chosen by the firms according to the following game structure. We assume that there is a time interval  $[0, t]$  of some positive length. In this time interval each firm chooses its output  $x_i$  that occurs at  $t$ . At  $t$  each firm can observe each other firm’s output decision. Hence, although actual output decisions may not necessarily occur simultaneously, due to simultaneous information revelation, the output choice is a standard Cournot–Nash game. Accordingly, the unique Cournot equilibrium is given by  $x_i^* = \frac{1}{n+1}$ . Total supply is given by  $X = \frac{n}{n+1}$  and the equilibrium price by  $p = \frac{1}{n+1}$ . Firms’ profits are  $\frac{1}{(n+1)^2}$ .

Next consider that two firms merge. A holding is formed with a joint headquarter and decision making units in each of the two affiliates, labelled  $L$  and  $I$ . As discussed briefly in the introduction, post-merger governance structure is characterized by two properties. First, information flows more easily between the merged affiliates than

between other firms. More precisely, we assume that the two merged firms can observe each other's output decision immediately when it occurs, and, therefore, prior to  $t$ . Second, the head quarter may control the sequencing of output decisions of the two affiliates and may force affiliate  $L$  to choose  $x_L$  prior to affiliate  $I$ 's decision. Hence, when  $I$  chooses  $x_I$ , it knows the choice  $x_L$  made by affiliate  $L$ . Of course, all other firms observe  $x_L$  and  $x_I$  only at  $t$ , at the same time when  $L$  and  $I$  also observe these other firms' output choices. This structure is common knowledge and we refer to a merger that results in a holding with two affiliates and this information and decision structure as *a merger with partial information sharing*.

The game which results after the merger has taken place is a sequential game without proper subgames. It can be interpreted as a market with "partial Stackelberg leadership" and we refer to the firm in the merger which moves first ( $L$ ) as the "leader". To the second firm in the merger ( $I$ ) we refer to as the "informed firm". To all other firms we refer to as the "uninformed firms", indexed  $u \in U$ .

A strategy of the leader is simply a number, its quantity  $x_L$ , and the same is true for the uninformed firms. The informed firm's strategy is, however, a *function* prescribing for each possible quantity of the leader a quantity of its own. We denote this function by  $f(x_L)$ .

It is obvious that this game has an infinite number of Nash equilibria, similarly to a standard Stackelberg game. But in contrast to a standard Stackelberg game the number of equilibria cannot be reduced by simple backward induction, i.e., by requiring subgame perfection. To solve the game let us proceed step by step.<sup>2</sup>

First, consider an uninformed firm  $u$  and let  $X_U$  denote total output of all uninformed firms. Its best-reply correspondence assigns to each possible combination of  $x_L$ ,  $f(x_L)$  and  $X_{U \setminus u} = \sum_{i \in U \setminus \{u\}} x_i$  a unique quantity  $x_u$  which maximizes  $x_u(1 - x_L - f(x_L) - X_U)$ . Thus firm  $u$ 's best reply is given by

$$x_u^* = \frac{1}{2}(1 - x_L - f(x_L) - X_{U \setminus u}). \quad (1)$$

The informed firm's best-reply correspondence assigns to each possible combination of  $x_L$  and  $X_U$  a function  $f$  such that  $f(x_L)(1 - x_L - f(x_L) - X_U)$  is maximized.

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<sup>2</sup>The following procedure will sometimes seem very tedious. But we feel that it helps to solve the basic problem once in a very clean way. When analyzing the extensions we will rely on short cuts which provide more elegance.

Therefore,

$$f^*(x_L) = \frac{1}{2}(1 - x_L - X_U) \quad (2)$$

has to hold. It is important to notice that for each combination of  $x_L$  and  $X_U$  there is an infinite number of functions  $f^*$  fulfilling this condition. The best-reply correspondence only demands that  $f^*$  assumes a certain value at one particular point and says nothing about the shape of the function elsewhere. Obviously, this is the reason for the multiplicity of equilibria.

However, requiring sequential rationality narrows down the set of functions for firm  $I$ . Sequential rationality demands that firm  $i$  reacts optimally in all its information sets. As the information sets of firm  $I$  are single-valued there are no problems of specifying  $I$ 's beliefs. Firm  $I$  can only react to what it knows about  $x_L$ . Taking into account that (2) has to hold, this implies that firm  $i$  must choose a function of the form

$$f^*(x_L) = Z - \frac{x_L}{2}. \quad (3)$$

In essence, this means that, demanding sequential rationality, we now can analyze a "truncated game" where  $Z$  is firm  $I$ 's only choice variable. This means that we can rewrite (1) and (2) as follows. For a firm  $u$

$$x_u^* = \frac{1}{2}(1 - \frac{1}{2}x_L - Z - X_{U \setminus u}) \quad (4)$$

has to hold and for firm  $I$

$$Z^* = \frac{1}{2}(1 - X_U). \quad (5)$$

Notice that (5) ensures uniqueness.

Next, we can focus on the leader  $L$ . In the truncated game its best-reply correspondence assigns to each combination of  $Z$  and  $X_U$  a unique quantity  $x_L$  maximizing  $x_L(1 - \frac{1}{2}x_L - Z - X_U)$ . Accordingly,

$$x_L^* = 1 - Z - X_U. \quad (6)$$

Using the symmetry of the uninformed firms, we can now solve the following simultaneous equations

$$\begin{aligned} x_u^* &= \frac{1}{2}(1 - \frac{1}{2}x_L^* - Z^* - (n-3)x_u^*) \\ Z^* &= \frac{1}{2}(1 - (n-2)x_u^*) \end{aligned} \quad (7)$$

$$x_L^* = 1 - Z^* - (n-2)x_u^*$$

which gives  $x_u^* = \frac{1}{n+2}$ ,  $x_L^* = \frac{2}{n+2}$ , and  $Z^* = \frac{2}{n+2}$ . The latter implies that the informed firm chooses  $f^*(x_L) = \frac{2}{n+2} - \frac{1}{2}x_L$  which yields in equilibrium  $x_I^* = \frac{1}{n+2}$ .

Taking this route to construct the unique sequentially rational equilibrium it may seem surprising that informed and uninformed firms supply identical quantities. But there is a simple general argument behind this result: In equilibrium firms know the quantities of all other firms. (About the informed firm they know the equilibrium function  $f^*(x_L)$ , but since they know  $x_L^*$  they also know  $x_I^*$ .) Thus, uninformed firms have to maximize  $x_u(1 - X_{-u}^*)$  while informed firms have to choose  $f(x_L)$  such that  $x_i(1 - X_{-i}^*)$  is maximized. Hence, the first order conditions are symmetric and  $x_i = x_u$  must hold in equilibrium.

As we have now solved the market game after the merger we can proceed by analyzing a) whether this merger is profitable, b) which effects it exerts on social welfare and c) which effects it exerts on the merged firm's competitors. All questions are not hard to answer.

In order to analyze the profitability of the merger we have to compare the joint profit of the two firms before and after they merge. Before, the joint profit is  $\frac{2}{(n+1)^2}$ . After, it is  $\frac{3}{(n+2)^2}$ . (Simply note that the price after the merger is  $\frac{1}{n+2}$ .) Thus, the change in profits is  $\frac{3}{(n+2)^2} - \frac{2}{(n+1)^2} = \frac{n^2-2n-5}{(n+2)^2(n+1)^2}$  which is positive if  $n^2 - 2n - 5 > 0$ , i.e., if  $n \geq 4$ .

In order to analyze social welfare it is (due to linearity) sufficient to compare the induced change in total quantities which is  $\frac{n+1}{n+2} - \frac{n}{n+1} = \frac{1}{(n+2)(n+1)}$  and unambiguously positive. Thus, the merger is welfare improving. Finally, we find that a competitor's profit is unambiguously reduced (from  $\frac{1}{(n+1)^2}$  to  $\frac{1}{(n+2)^2}$ ).

We summarize our results in

**Proposition 1** *In symmetric linear Cournot markets with at least four firms a bilateral merger with partial information sharing is profitable and welfare-improving. Furthermore, it reduces competitors' profits.*

### 3 Two extensions

In this section we briefly address the following two questions: First, we ask whether, once two firms have merged, there are still incentives for other pairs of firms to do the same. After that we analyze whether firms have incentives to create large mergers with more than one firm.

In order to answer the first question we analyze a market where  $k$  pairs of firms have merged. There are  $k$  leader firms indexed  $l \in L$ , and  $k$  informed firms indexed  $i \in I$ , as well as  $n - 2k$  uninformed firms, indexed  $u \in U$ . (One leader firm  $l$  informs exactly one follower firm  $i$ .)

Applying the same reasoning as above we find that the following conditions for equilibrium quantities must be fulfilled. For firm  $i$  which knows the quantity of firm  $l$  it must hold that

$$x_i = \frac{1}{2}(1 - x_l - X_{L \setminus l} - X_{I \setminus i} - X_U). \quad (8)$$

For the respective leader firm  $l$  it must hold that

$$x_l = \frac{1}{2}(1 - X_{L \setminus l} - X_{I \setminus i} - X_U) \quad (9)$$

and, finally, we know

$$x_i = x_u \text{ for all } i \text{ and } u. \quad (10)$$

Using symmetry we find the following equilibrium quantities:  $x_l^* = \frac{2}{n+1+k}$  and  $x_i^* = x_u^* = \frac{1}{n+1+k}$ . (As can be easily seen we obtain for  $k = 1$  the solution found in the above section.)

Total output is  $\frac{k+n}{n+1+k}$  and the price is  $\frac{1}{n+1+k}$ . The profit of two unmerged firms is  $\frac{2}{(n+1+k)^2}$ . Now suppose two previously separate firms merge, too. Their resulting joint profit will be  $\frac{3}{(n+2+k)^2}$ . Analyzing the difference between these two terms it is easy to see that their joint profit increase as long as  $n > 1 + \sqrt{6} - k$ . In other words, it is positive, regardless of  $k$ , as long as  $n \geq 4$ , i.e., if one merger is profitable, any number of bilateral mergers is profitable.

In order to analyze whether firms have incentives to create large mergers with more than one firm we consider the case of a single merged firm with  $m + 1$  affiliates, one leader unit and  $m$  informed units.<sup>3</sup>

Again applying the same logic as in the basic model and already using symmetry

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<sup>3</sup>It is easy to show that it is optimal only to have one leader unit within a merged firm with more than two affiliates.



we get the following simultaneous equation for the equilibrium quantities

$$x_L = \frac{1}{2}(1 - (n - m - 1)x_u)$$

$$x_i = \frac{1 - x_L - x_u(n - m - 1)}{m + 1} \quad (11)$$

$$x_u = x_i$$

which gives  $x_L^* = \frac{m+1}{n+m+1}$  and  $x_i^* = x_u^* = \frac{1}{n+m+1}$ .

In order to see how many firms can profitably merge into one we first compute the joint profit of a merged firm with  $m$  affiliates which is  $\frac{2m+1}{(n+1+m)^2}$ . The merged firm plus one uninformed firm earn together  $\frac{2(m+1)}{(n+1+m)^2}$ . This we have to compare with the profit of a merged firm with  $m + 1$  affiliates which is  $\frac{2m+3}{(n+2+m)^2}$ . Taking the difference we find that the optimal size (or the critical size after which merging with additional firms is no longer profitable) crucially depends on the number of firms  $n$ . The optimal size is given by the largest (integer)  $m$  for which

$$m \leq \frac{1}{3}(\sqrt{4n^2 + 2n + 1} - n - 4) \quad (12)$$

holds. This implies, for example, that as long as there are less than 7 firms in a market only bilateral mergers are profitable.

We summarize our results in

**Proposition 2** *In symmetric linear Cournot markets with at least four firms any number of bilateral mergers with partial information sharing is profitable. For multilateral mergers there is an optimal number of firms participating.*

## 4 Discussion

Empirical evidence on the effects of mergers is mixed even where standard theory makes unambiguous predictions. For example, Banerjee and Eckard (1998) find that during the first great merger wave from 1897 to 1903 competitors of merging firms suffered significant losses which is inconsistent with the traditional modelling of mergers. The observation is, however, consistent with our approach which predicts such losses.

Our approach also predicts the opposite of standard models with respect to the profitability of mergers in a market with linear costs and with respect to their welfare

implications. As the new wave of mergers still is irresistible we observe mergers in virtually all kinds of markets, including those where the linear-cost assumption seems well-justified. In the traditional approach where one firm “disappears” after a merger this is an unsolved puzzle. But empirical evidence clearly shows that firms acquiring other firms typically keep target management (Hubbard and Palia 1999) and that the “multilayered subsidiary form” (which is implicitly assumed in our model) is the standard organizational form of a merged firm (Prechel, Boies, and Woods 1999). As we have shown, such an organizational form may have a significant impact on the structure of the market which provides a new rationale for mergers.

In the present analysis this rationale depends on the assumption that a joint headquarter can govern the (timing) decisions of its affiliates. Although this does not strike us as a particularly strong assumption we suspect that it is possible to rely only on the much weaker assumption that information flows more freely within a merged firm. Without the headquarter imposing a rule, one would then have to study how the timing decisions of the affiliates emerge endogenously. The recent literature on endogenous timing (see, for example, Hamilton and Slutsky 1990) suggests that in this case one affiliate may endogenously become a (partial) Stackelberg leader—exerting the same effect on market structure as in our model which allows strategic governance by the headquarter.

Our model can also account for the observations that there are often many bilateral mergers in one market while bigger multilateral mergers which are predicted, for instance, by the analysis in Gaudet and Salant (1991) are less frequent. Its policy implications are twofold: Socially, mergers may be more welcome than traditional views suggest. This, however, may depend on the organizational form merged companies choose. Hence, in judging the (anti)competitive effect of mergers governing bodies may wish to be regardful of how the merged firm plans to operate.

On a more general level, the model suggests that one can only fully understand the consequences of merger when carefully considering its consequences for market structure. If one does, the standard view that mergers have to induce cost advantages to be profitable and/or welfare-improving is no longer warranted.

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