

WELFARE ENHANCING MERGERS

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Abstract: We analyze the welfare effects of horizontal mergers in the context of a Cournot oligopoly model in which firms have different marginal costs of production. A merger may allow for a shift from less efficient to more efficient producers (rationalization of production). A merger may increase social welfare because the beneficial effects of a merger (lower production cost) can outweigh the detrimental effects (increased market concentration). Whether or not a merger of two firms leads to an increase in welfare depends upon whether one of the two merging firms has costs that are sufficiently high relative to the industry average.

1. Introduction

Horizontal mergers are treated harshly under U.S. antitrust law. The 1984 Merger Guidelines generally do not permit mergers that increase market concentration, as measured by the Herfindahl–Hirschman Index (HHI), by more than a specified amount.¹ Horizontal mergers are treated harshly because they increase market concentration, which tends to increase price and decrease social welfare. Besides the market concentration effect, however, horizontal mergers may have beneficial welfare effects by lowering production costs. A merger may allow participating firms to lower production costs through economies of scale or synergy gains. Further, a merger may allow for a shift from less efficient to more efficient producers (rationalization of production). A merger may increase social welfare because the beneficial effects of a merger (lower production cost) can outweigh the detrimental effects (increased market concentration).

In this paper, we analyze a model of horizontal mergers in which the only welfare gain comes from shifting production from higher cost to lower cost producers. Even without economies of scale or synergies, it is quite possible that a horizontal merger can increase social welfare. Somewhat surprisingly, this can be true even if the merger is not profitable for the firms involved. Whether or not a merger of two firms leads to an increase in welfare depends upon whether one of the two merging firms has costs that are sufficiently high relative to the industry average. With larger numbers of firms, the degree to which costs must exceed the industry average shrinks. With a large number of firms, as long as one of the two firms have costs above the industry average, then the merger will increase welfare.

That cost considerations are potentially important in assessing the welfare consequences of mergers has been recognized by economists for some time. Williamson [1968] described the importance of having an efficiency defense for mergers. More recently, Farrell and Shapiro [1990] analyze the welfare consequences of horizontal mergers in a model with general cost and demand functions. In order to derive general results on when mergers increase welfare, Farrell and Shapiro use differential techniques.

¹The HHI is defined as the sum over all firms in the industry of the squared market shares of each firm:

$$HHI = \sum_{i=1}^N s_i^2$$

where s_i is firm i 's percentage market share ($0 \leq s_i \leq 100$). In general, if the pre-merger HHI is between 1000 and 1800, then a merger will be challenged if the merger increases the HHI by 100 or more. If the pre-merger HHI is above 1800, then the merger will be challenged if the merger increases the HHI by 50 or more.

While differential techniques are appropriate in most economic applications, mergers are by definition lumpy (non-differentiable) events. Farrell and Shapiro finesse this issue by integrating over an appropriate range of "differential" mergers, but this approach is only useful if the effects of interest have the same sign along the entire path. Furthermore, their condition is an implicit one, as it relies on an endogenously determined variable.

Our approach in this paper is less general than that of Farrell and Shapiro in that we use specific demand and cost functions. In return, our approach facilitates graphical exposition and we are able to find a simple and intuitive (necessary and sufficient) condition for a horizontal merger to raise social welfare. In the next section, we describe our model. In part A, we use the model to show the effect of a merger on social welfare. In part B, we analyze the profitability of the merger for the participating firms and compare the factors that make a merger profitable with those that make it socially beneficial. In section 3, we conclude with several remarks about horizontal merger policy.

2. The Model

There are $i = 1, 2, \dots, N$ firms that produce a homogeneous product. Let q_i be the production of firm i and let $Q = \sum_{i=1}^N q_i$. Firms act as Cournot competitors. Each firm can produce the good at constant marginal cost of c_i , $c_i \in [\underline{c}, \bar{c}]$ for all i . The demand curve is given by: $Q \equiv D(P) = a - P$, where P is the market price.

Consider a merger of any two firms i and j . After the merger, the newly combined firm has multiple plants that have potentially different marginal costs of operation. The most efficient means of production involves shutting down the higher cost plant and producing all output from the lower cost plant. This is equivalent to saying that the higher cost of the two merging firms leaves the industry upon a merger. This is admittedly too simple a representation for what happens in a horizontal merger. Generally speaking, the merger transforms the cost functions of the individual firms into a cost function for the merged firm, which can depend in a complex way upon the assets of each individual firm. The constant cost formulation, however, focuses attention on the cost savings of a merger (rationalization of production) in a particularly clear fashion.

A. The Change in Social Surplus with a Merger

We use social surplus as our partial equilibrium measure of welfare. The change in social surplus with a merger can be written as the sum of the changes in industry profit and consumer surplus. Further, industry profit is the loss in profit from the firm that shuts down (the higher cost of the merging firms) plus the change in profit from continued operations at the other firms. Suppose firm z ceases operations post-merger, then the change in social surplus is

$$\Delta W = \Delta CS + \Delta \Pi_{-z} + \Delta \Pi_z. \quad (1)$$

where ΔW is the change in welfare, ΔCS is the change in consumer surplus, $\Delta \Pi_{-z}$ is the change in the profit of all firms $i \neq z$, and $\Delta \Pi_z$ is the change in the profit of firm z .

Under what conditions is the change in welfare positive with a merger? To answer this question, we analyze each of the component parts of the change in welfare. Let P_0 represent the equilibrium market price pre-merger and let P_1 represent equilibrium market price post-merger. Similarly let Q_1 and Q_0 represent pre- and post-merger equilibrium levels of market output. The change in consumer surplus with the merger is

$$\Delta CS = \int_{P_0}^{P_1} D(p) dp = -(P_1 - P_0)Q_1 + (P_1 - P_0)(Q_1 - Q_0)/2. \quad (2)$$

Let q_z be the pre-merger equilibrium output of firm z . The change in profit for firm z is the negative of the profit that the firm earned pre-merger since firm z ceases operations post-merger

$$\Delta \Pi_z = -q_z(P_0 - c_z). \quad (3)$$

For the other firms in the industry there are two effects. Each firm will adjust output in response to the new market structure. The merger will also affect market price. The change in profits for the remaining firms in the industry is

$$\Delta \Pi_{-z} = (P_1 - P_0)Q_1 + \sum_{i \neq z} (P_0 - c_i) \Delta q_i. \quad (4)$$

where Δq_i represents the change in equilibrium output for firm i

Combining terms, the change in social welfare with the merger is

$$\Delta W = \sum_{i \neq z} (P_0 - c_i) \Delta q_i - q_z (P_0 - c_z) + (P_1 - P_0)(Q_1 - Q_0)/2. \quad (5)$$

This expression can be simplified by using equilibrium relationships. In Cournot equilibrium with N firms, linear demand and constant marginal cost, the reaction function for firm i is

$$q_i = (1/2)(a - c_i - \sum_{j \neq i} q_j). \quad (6)$$

Summing equation (6) over all the $N-1$ firms $i \neq z$, we can show how all of these firms react to changes in output by firm z

$$Q_{-z} = \frac{(N-1)a - \sum_{i \neq z} c_i}{N} - \frac{(N-1)q_z}{N}. \quad (7)$$

Therefore, with a merger that results in firm z shutting down, $\Delta Q_{-z} = (N-1)q_z/N$, $\Delta q_i = q_z/N$ and $\Delta Q = -q_z/N$. Further, we note that the post-merger equilibrium price, P_1 , is related to pre-merger equilibrium price, P_0 , in the following way: $P_1 = \frac{N+1}{N} P_0 - \frac{1}{N} c_z$.

Using these expressions in equation (5) gives

$$\begin{aligned} \Delta W &= \sum_{i \neq z} (P_0 - c_i) q_z/N - q_z (P_0 - c_z) - (1/2)(q_z/N) \left(\frac{N+1}{N} P_0 - \frac{1}{N} c_z - P_0 \right) \\ &= q_z/N \left[(N-1)P_0 - \sum_{i \neq z} c_i - NP_0 + Nc_z - (P_0 - c_z)/2N \right] \\ &= \frac{q_z}{N} \left[N(c_z - \bar{c}) - (1+1/2N)(P_0 - c_z) \right] \end{aligned} \quad (8)$$

where $\bar{c} = \sum_{i \in N} c_i/N$. Since $q_z/N > 0$, the sign of the change in social welfare is equal to the

sign of the expression inside the brackets. In terms of comparative statics, ΔW will

increase if N increases by adding a firm with marginal costs equal to $\bar{c}$; if c_z increases; if $\bar{c}$ decreases.²

If firm z has average or below average costs, welfare will fall with the merger. However, if firm z has sufficiently high costs, the merger will have a positive effect on welfare. The degree to which the cost of firm z must exceed average marginal cost for the industry in order for the merger to increase welfare is a function of the number of firms in the industry. As can be seen in equation (8), when N is large, marginal costs for firm z need not exceed the average marginal cost for the industry by much before a merger increases social welfare. With large N , the demise of one firm will not decrease industry production by much. The positive effect of shifting production to lower cost firms will outweigh the negative effect of a decrease in output. Even in tight oligopolies, however, a merger can increase welfare.³

In figure 1, we show the welfare consequences of a merger in the case of three firms, two of which are high cost and one of which is low cost. Equilibrium market price and quantity before the merger are represented as P_0 and Q_0 respectively. The combined output of the high cost firms is denoted Q_0^H . After a merger takes place, there will be only one high cost and one low cost firm in operation. Total output falls to Q_1 and the output of the high cost firm is Q_1^H . Market price rises to P_1 .⁴ The area ABQ_1Q_0 represents a loss in welfare from a contraction in market output that results from the merger. The area $STQ_1^H Q_0^H$ represents a welfare gain from lower production costs. The area of $STQ_1^H Q_0^H$ is equal to the area of ACQ_0Q_1 . Therefore, the total net benefit of the merger is equal to the area of the triangle ABC .

In general, when a high cost producer is merged out of the industry, production is shifted away from high cost production. Even though this lessens competition, this effect can be more than offset by increasingly efficient production.

²In equilibrium, $P_0 = (a - N\bar{c})/(N+1)$. Therefore, ΔW will increase if the demand intercept (a) falls.

³At the extreme, a merger creating a monopoly can be welfare enhancing. In light of equation (8), with $N=2$, a merger is beneficial when $22(c_2 - c_1) - 5(a - c_1) > 0$. Since the pre-merger price is $P_0 = (a + c_1 + c_2)/3$ and the monopoly price is $(a + c_1)/2$, it follows that a merger is socially beneficial whenever the pre-merger price exceeds 9/11 of the monopoly price. Put differently, a merger can drive price up nearly 20% and still be beneficial.

⁴In this example, the demand function is $D(P) = 20 - P$, the high cost firms have a marginal cost of \$4 and the low cost firm has a marginal cost of \$0. Cournot equilibrium output will be 7 units for the low cost firm and 3 units for each of the high cost firms. Market price will be \$7. After the merger, the low cost firm will produce 8 units and the high cost firm will produce 4 units. Market price will rise to \$8.

B. Comparison of Private and Social Consequences of a Merger

In a model where all firms had the same constant marginal cost, Salant, Switzer and Reynolds [1983] found that profits of participating firms were reduced by a horizontal merger unless at least 80% of the firms in the industry were involved.⁵ In our model where costs differ among firms, more mergers are profitable. Whether a merger is privately profitable and whether it is socially beneficial, however, are two different questions. As is well known, there are cases where a horizontal merger is privately profitable but socially detrimental (the main reason for strict antitrust policy on horizontal mergers). However, more surprisingly, mergers can be socially beneficial but not privately profitable. In this section, we compare the factors that make it likely for a merger to be profitable with those factors that make it likely to be socially beneficial.

Suppose that firm i merges with firm z . Let $c_i < c_z$ so that firm z will shut down after the merger.⁶ The change in profit for the firms involved in the merger is

$$\Delta\Pi = -\Pi_z + \Delta\Pi_i. \quad (9)$$

This expression can be written as

$$\Delta\Pi = -q_z(P_0 - c_z) + q_i^0(P_1 - P_0) + \Delta q_i(P_1 - c_i) \quad (10)$$

which can be simplified to

$$\Delta\Pi = \frac{q_z}{N} \left[2(P_0 - c_i) - \frac{N^2 - 1}{N} (P_0 - c_z) \right]. \quad (11)$$

As shown in equation (11), whether a merger is profitable or not depends upon three factors: i) the gap between pre-merger price and marginal cost for firm i , ii) the gap between pre-merger price and marginal cost for firm z , and iii) the number of firms. When firms i and z merge, operation from z ceases and operation from i increases. The per unit value of the increase in output of firm i is the difference between price and

⁵Other papers that analyze the profitability of mergers are Davidson and Deneckre [1984] Deneckre and Davidson [1985], Perry and Porter [1985] and Kamien and Zang [1990].

⁶We do not analyze the complete game of which mergers would take place in equilibrium. At the merger decision stage it is possible that any of several firms would be better off merging with a high cost firm rather than having no mergers take place, but a firm is even better off if a rival firm merges with the high cost firm rather than doing so itself. This occurs because there is a positive externality to non-participating firms from a merger.

marginal cost ($P_0 - c_i$). Similarly, the per unit value of the decrease in output of firm z is $P_0 - c_z$. Firm i will not expand output by the same amount as firm z contracts. With more rival firms, the expansion of firm i per unit of contraction of firm z will be less. In other words, with more rivals, less of the gain in profit from expansion of output or increase in price will go to firm i .

Figure 2 graphs the change in profit using the same example given in the previous section. Let q_j^0 be the pre-merger equilibrium output of the firm not involved in the merger. The change in profit with the merger is equal to the area of $A + B - C - D$. Area A is the increase in profit due to an increase in price. Areas $B - C - D$ are the sum of changes in profit from the change in production for the firm with the merger and a shift to lower cost production. On the other hand, the welfare change due to the merger is equal to the area $B - D - E$. The difference between the change in profit for the firm and the change in welfare, i.e., the excess private incentive for a merger, is $A + E - C$. Areas $A + E$ are directly related to the effect of the merger on increasing market price. Area C is related to the change in output for the merged firm. All of these variables will tend to fall in absolute value terms with increases in the number of firms in the industry. Unlike profit, social welfare is more likely to increase with a merger when N is large. With large N , the fall in output (rise in price) with the merger is small. Lower production cost, however, occur regardless of the number of firms in the industry.

3. Horizontal Merger Policy

Prospective mergers are analyzed in accordance with the Department of Justice's 1984 merger guidelines. If the pre-merger HHI exceeds certain threshold values and if the merger will cause a non-trivial increase in the index, then the merger is likely to be challenged. To what extent does following this type of structural rule match challenging mergers that result in lower welfare? That the match is not perfect is easy to demonstrate. In fact, the numerical example given in section 2, upon which figures 1 and 2 are based, is a case where the merger would increase welfare but would be challenged under the merger guidelines.⁷ However, several arguments backing the use of the merger guidelines can be made.

In the context of our model, each firm's equilibrium output prior to the merger is $(P_0 - c_i)/(N+1)$, so that the shares of the two firms in question are $(P_0 - c_i)/N(P_0 - \bar{c})$ and $(P_0 - c_z)/N(P_0 - \bar{c})$. Hence, the increase in the index with the merger is

⁷The HHI pre-merger is 3964 while the HHI post-merger is 5556.

$$\Delta HHI = (P_0 - c_i)(P_0 - c_z)/[N(P_0 - \bar{c})]^2. \quad (12)$$

This increment will be smaller the larger is c_z or N , and the smaller is $\bar{c}$ or a . Thus, comparing these results the comparative statics we derived following equation (8) give some loose justification for the Justice Department's merger guidelines.

Welfare is supposed to be higher with lower values of the HHI. With some simple algebraic manipulation, the HHI can be rewritten as $HHI = 1/N + \text{Var}(s_i)$, where $\text{Var}(s_i)$ is the variance of the firms' market shares.⁸ A merger that results in the shutting down of a high cost firm will increase the HHI (reduce welfare) by reducing N and will reduce the HHI (increase welfare) by reducing $\text{Var}(s_i)$. Where the relationship between the HHI and welfare breaks down is with the level of variance. Higher variance of market share, which is tied to differences in the relative efficiency of firms, tends to increase welfare while it also leads to an increase, instead of a decrease, in the HHI.⁹

Certainly as a first pass at the problem of horizontal mergers, the HHI provides useful information. As we showed, cases where it would be privately profitable but not socially optimal for a merger to occur are most likely to happen when N is small, i.e., when the HHI is big. However, efficiency arguments should not be overlooked. In this paper, we have shown that a welfare enhancing merger can take place when firms are not equally efficient. Just relying on the a structural measure like the HHI will lead to rejection of some welfare enhancing mergers. The results of this paper did not include possible economies of scale or synergy effects, which would strengthen the argument.

⁸The derivation of this result is as follows. Define $\bar{s} = \sum s_i/N = 1/N$. Then,

$$\begin{aligned} HHI &= \sum s_i^2 = \sum (s_i^2 + \bar{s}^2 - \bar{s}^2) \\ &= 1/N + \sum (s_i^2 - \bar{s}^2) = 1/N + \sum (s_i^2 + 2s_i\bar{s} - 2s_i\bar{s} - \bar{s}^2) \\ &= 1/N + \sum (s_i^2 - 2s_i\bar{s} + \bar{s}^2) = 1/N + \sum (s_i - \bar{s})^2 \\ &= 1/N + \text{Var}(s_i). \end{aligned}$$

⁹There are competing reasons to be suspicious of mergers which lead to greater symmetry. Mason et al. [1992] have shown that symmetric experimental markets are far more likely to be collusive than asymmetric markets.

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FIGURE 1: The Welfare Effects of a Merger



