Failing Firm Defense with Entry Deterrence*

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Abstract

Under the principle of the Failing Firm Defense (FFD) a merger that would be blocked due to its harmful effect on competition could be nevertheless allowed when (i) the acquired firm is actually failing, (ii) there is no less anti-competitive alternative purchase, (iii) absent the merger, the assets to be acquired would exit the market. This paper focuses on potential anti-competitive effects of a myopic application of the third requirement by studying consequences of a horizontal merger on entry in a Cournot oligopoly with a failing firm. If the merger is blocked, entry occurs and consumer welfare is bigger when the industry is highly concentrated because gains due to augmented competition exceed losses due to shortage of output.

Keywords: Failing Firm Defense, Entry Deterrence, Consumer Surplus.

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1 Introduction

According to the competition law in most developed countries, mergers are illegal when creating or strengthening dominant positions.[1] A merger that would be blocked due to its adverse effect on competition could be nevertheless allowed if the firm to be acquired is failing under the so-called Failing Firm Defense (FFD).

The FFD is well established in the U.S. case-law and is included in the department of Justice and Federal Trade Commission. The FFD was first applied in the case of International Shoe's acquisition of a financially troubled competitor, McElwain Company: the Court allowed the merger after verifying that there was little direct competition between the two companies. The principle was developed further in the case of Citizen Publishing Co., when the Court rejected a merger with a distressed newspaper company by stating tighter prerequisites for the defence to be accepted. Preserved the two conditions mentioned for International Shoe, the grave probability of business failure faced by the company and the lack of alternative purchasers, a third requirement was added: the prospects of reorganization through receivership or bankruptcy proceedings must be "dim or non-existent".

In the EU the case of Kali und Salz/MdK/Treuhand (Case No IV/M.308) and the more recent one in the chemicals sector Basf/Eurodiol/Pantochim (Case No COMP/M.2314) gave the opportunity to the European Commission of setting out extensively the three requirements which must be met to apply the concept of a rescue merger:

- the acquired undertaking would immediately go bankrupt if not bought out by another undertaking (i);
- there is no less anti-competitive alternative purchase (ii);

[1] See Farrell and Shapiro (1990) and Motta (2004) for a general discussion of the effects of mergers on competition.

- the assets to be acquired would be exit the market if not taken over by another firm (iii).[2]

First, the Court of Commerce confirmed that both undertakings would have to be declared bankrupt if a buyer for them were not approved. Second, although a number of competitors were contacted, after a close look at the business activities of the failing undertakings no other firm apart BASF was interested in submitting offer. Third and, as we will see, more interesting for the purpose of this paper, the Commission stated that the assets of the failing firms would have definitely exited the market if the merger had been blocked because an immediate takeover by a third party seemed to be unlikely because "a shutdown of the production would cause additional costs for new catalysts if the plant was restarted". Moreover, the availability of a qualified workforce was crucial for the operation of the chemical plant; the Commission noted that "as parts of qualified workforce have already left and others will certainly do so after bankruptcy is declared, the incentives for any investor to take up business after bankruptcy are fairly low". The Commission stated that absent the merger the exit of assets and production capacities of Eurodiol and Pantochim would have caused a significant capacity shortage for products which were already offered under very tight capacity constraints. At least for a considerable period of time, compensation for this capacity reduction would have been impossible. As a consequence, a strong price increases was supposed to emerge given the capacity constraints and the inelastic demand for those products. The Commission concluded that the deterioration of the competitive structure resulting from the merger would have been less significant if it was allowed and in 2001 BASF was permitted to acquire Eurodiol and Pantochim, which were in financial distress.

While the literature on mergers generally is very large, to our knowledge

[2] See the contribution in OECD Roundtables, "Failing Firm Defense", OECD/GD(96)23, *Competition Policy Roundtables, and Failing Firm in Light of Global Competition.*

there are only two papers analysing the FFD specifically. Mason and Weeds (2003) argue that rescue mergers are desirable to encourage ex-ante entry. More exactly, even if mergers lead to a more concentrated market structure and consequently lower consumer surplus, the possibility of mergers in times of financial distress increases the willingness of firms to enter the industry, therefore increasing consumer surplus in the long run. They conclude that a more lenient merger policy, i.e. allowing merger at an early stage of financial distress when the failure is not certain, can lead benefits to consumers. Persson (2005) analyses the welfare consequences of the FFD, by focusing on the ex-post efficiency of sales of the failing firm's assets. He finds that a smaller or a noncompetitor buyer may not be the socially preferred buyer and he calls for an improvement of the auction-selling procedure. While the first paper analyses the optimal degree of policy leniency, being thereby related to the requirement (i) of FFD's law, and the second one deals with the optimal design of the auction for the failing firm, thereby concerning the requirement (ii), the current paper mainly concentrates on potential anti-competitive effects produced by a myopic application of the requirement (iii).

The idea that an anticompetitive merger is better than a company closing its doors has intuitive appeal. If the failing firm's assets could be expected to remain the market in other hands -either a somehow rejuvenated original firm, a new firm, or even a firm with a smaller market share- then their acquisition by a leading firm would raise conventional antitrust concerns. Instead, if they would otherwise leave the market, the effect of the acquisition is to increase industry capacity. In our paper we suppose that the three requirements are satisfied, hence we expect that the additional capacity increases output and lowers price compared to the case of blocked merger. Yet, we argue that a trade-off between preservation of assets and entry deterrence should be taken into account. Indeed, allowing the merger is equivalent to decrease the cost of internal capacity expansion by the acquiring firm.

It has been given evidence (Spence, 1979) that in oligopolistic markets leading firms may maintain excess capacity as a deterrent to potential entrants or to discipline smaller rivals. Excess capacity permits existing firms to expand output and reduce price when entry is threatened, thereby reducing the prospective profits of the new entrant which operates on the residual demand curve.

The basic idea of our analysis is that the merger can give enough capacity to the acquiring firm to deter entry of new competitors.[3] In that case, even if the three requirements of FFD are satisfied, we ask whether the Antitrust Authority (AA) should allow the merger to prevent shortage of output or block it to preserve competition. We assume that the AA assess the merger according to the maximization of consumer welfare (Motta and Vasconcelos, 2005). We consider a symmetric oligopoly à la Cournot where an unexpected exogenous shock makes one firm failing. A merger between the failing firm and one of the other firms is then proposed: absent the merger, assets of the former are assumed to exit the market. All potential buyers are symmetric, hence no less anti-competitive alternative purchase is available. We study effects of the merger on entry and we find that it occurs when the merger is blocked, whereas no entry may occur when the merger is allowed. A forward looking AA which takes into account the above effects may find that the consumer surplus is greater by blocking the merger rather than allowing it for, under some parametric conditions, gains due to lower concentration outdo losses due to shortage of output.

The remainder of the paper is organized as follows. The formal model is laid out in Section 2. Section 3 studies effects of the horizontal merger on entry. Section 4 establishes conditions under which the merger should be either allowed or blocked on the basis of consumer surplus. Section 5 concludes.

[3] We follow Dixit (1980), who assumes that entry decision depends on whether the entrant ends up with positive profits in the Cournot equilibrium. Our approach differs for we suppose that, before the competition in quantities, the incumbent can expand output also through the acquisition of the failing firm assets and not only through strategic capacity investment.

2 The model

In this section we consider a symmetric Cournot oligopoly where the number of incumbents is determined by a set-up entry cost and we describe the timing of the model. We then introduce an unexpected exogenous shock that makes one firm failing. Finally, we study the new Cournot equilibria when an horizontal merger between the failing firm and one of the remaining firms is either allowed or blocked.

2.1 Symmetric Cournot Oligopoly

At $t = -1$, m firms incur a fixed set-up cost F to enter an industry with linear market demand

$$p(Q) = a - bQ, \tag{1}$$

where $Q = \sum_{i=1}^{m} q_i$ is the industry output. Let the slope of the demand curve b be equal to 1. Total costs of production of the representative firm i are given by

$$C = cq_i + rK_i + F, \tag{2}$$

where $c \geq 0$ is the constant marginal cost for output q_i and r is the constant marginal cost for capacity K_i. We assume that a unit of capacity is needed to produce a unit of output and, following Dixit (1980), we anticipate that at equilibrium $K_i = q_i$. Profit of the firm i is thus as follows:

$$\left[a - \left(\sum_{j \neq i} q_j + q_i\right) - (c + r)\right] q_i - F. \tag{3}$$

The firms choose their output levels simultaneously to maximize (3). Due to symmetry of total production costs, optimal quantities are equal for all firms and given by $\frac{a-c-r}{m+1}$. The associated optimal level of profit net of F is

$$\pi^*(m) = \left(\frac{a - c - r}{m + 1}\right)^2. \tag{4}$$

Assumption 1 $\underline{F} < F \leq \overline{F}$, where $\underline{F} = \pi^* (n+1)$, $\overline{F} = \pi^* (n)$ and $n \geq 2$. Assumption 1 states that only n entrants make nonnegative profits: a symmetric oligopoly à la Cournot arises.[4] Equilibrium quantity of each firm is

$$\overline{K} = \frac{a-c-r}{n+1}, \tag{5}$$

and industry output is

$$Q_{-1} = n\overline{K}. \tag{6}$$

Assumption 2 $0 \leq r < \overline{r}$,

where $\overline{r} = \frac{10-3\sqrt{10}}{10}(a-c)$. Assumption 2 states that the capacity cost r is low with respect to the market size and implies $\overline{K} > 0$.[5]

Before proceeding, we describe the timing of the model, which is shown in Figure 1.

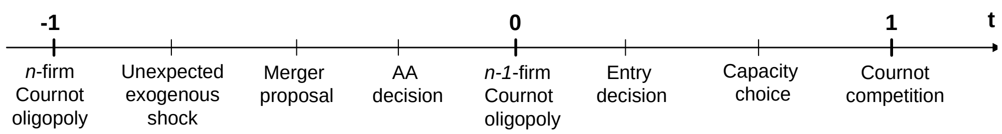

Figure 1: Timing of the model.

1. At $t = -1$, the market structure is a symmetric n-firm oligopoly à la Cournot.

2. Between $t = -1$ and $t = 0$, an unexpected exogenous shock makes one firm failing. The failing firm and one of the remaining $n-1$ firms advance

[4] Throughout the paper we assume that a firm enters the industry when its profit is zero. An ε reasoning may be used to make the argument more appealing.

[5] Increasing the upper bound on r to $a-c$ complicates computations without adding interest to our results.

a merger.[6] Finally, the AA decides whether to allow the merger or block it on the basis of consumer surplus. Absent the merger, assets of the failing firm are assumed to exit the market.

3. At $t = 0$, the firms compete simultaneously over quantities.

4. Between $t = 0$ and $t = 1$, $m' \geq 0$ potential entrants can build and the incumbents can enlarge capacity. The following first stage of a two-stage game is played: before building the capacity the potential entrants choose whether to enter.

5. A $t = 1$, the second stage of the game is played: after observing the choice of the entrants, the firms compete à la Cournot.

We compute equilibria by assuming that parameters of the games are common knowledge and by restricting our attention to pure strategies.

2.2 Failing Firm

As anticipated before between $t = -1$ and $t = 0$ an unexpected exogenous shock makes one firm failing.[7] The failing firm decides to merge with one of the remaining $n - 1$.

We analyze the Cournot game at $t = 0$ by taking into account that the firms are capacity constrained, because the potential for producing can be expanded only after $t = 0$. We consider separately the case where the merger is allowed and where it is blocked.

[6] Profits of the merged firm are higher than the sum of profits made by the two incumbents when the failing firm exits the market. Furthermore, the latter is assumed to make zero profits in the case of failure, hence it prefers to merge even if a big fraction of the pie is left to the other firm. As a consequence, the merger is profitable for both parties. See Perry and Porter (1985) for a discussion on incentives to merge due to efficiency gains.

[7] An explanation of the failure compatible with the model could be the following: if the firm is highly leveraged, an unforeseen idiosyncratic financial shock can make it unable to repay interests on debt.

In the former case, there are $n-2$ no-merged firms with capacity $\overline{K}$, while the merged firm can produce up to $2\overline{K}$.

Lemma 1 *When the merger is allowed, the Cournot equilibrium at $t=0$ is such that each no-merged firm produces $\overline{K}$ and the merged firm produces*

$$\begin{cases} \frac{3(a-c)+r(n-2)}{2(n+1)} \in \left(\overline{K}, 2\overline{K}\right) & \text{if } n < n_1, \\ 2\overline{K} & \text{if } n \geq n_1, \end{cases} \tag{7}$$

where $n_1 = \frac{a-c-2r}{r}$. Industry output is

$$Q_0^A = \begin{cases} \frac{(2n-1)(a-c)-r(n-2)}{2(n+1)} & \text{if } n < n_1, \\ n\overline{K} & \text{if } n \geq n_1. \end{cases} \tag{8}$$

Formal proofs of this and all next results are in the Appendix. If the industry is sufficiently concentrated (i.e. $n < n_1$), the merged firm prefers not to sell all the capacity with the aim of increasing the market price, because it maintains a significant demand share even if it restricts output. As a consequence, Q_0^A is lower than industry output before the failure. For higher n the above raising price strategy turns out to be not profitable and the merged firm increases production up to the capacity.

If the merger is blocked, assets of the failing firm are assumed to be lost: $n-1$ symmetric firms remain in the industry with capacity equal to $\overline{K}$.

Lemma 2 *When the merger is blocked the Cournot equilibrium at $t=0$ is such that each firm produces $\overline{K}$. Industry output is*

$$Q_0^B = (n-1)\,\overline{K}. \tag{9}$$

Symmetric Cournot equilibrium would require $n-1$ remaining firms to increase the production to $\frac{a-c}{n}$. Such a solution is however not feasible because of the capacity constraints, hence the equilibrium strategy is to produce as much as possible. Notice that $Q_0^A > Q_0^B$: industry output is higher if the merger is allowed.

3 Entry Deterrence

In this section we study the two-stage game between incumbents and entrants after $t = 0$ by considering separately the case where the merger is allowed and the case where it is blocked. Output costs $c + r$ per unit for the potential entrants because they incur both the production cost c and the capacity cost r. On the contrary, incumbents incur the latter only if they decide to produce more than the capacity. The entrants also bear the fixed set-up cost F. The game is solved by backward induction. We proceed in the following steps:

- we compute second stage optimal quantities and we verify whether the incumbents decide to enlarge capacity by analyzing the case where m' entrants decide to enter;
- we check how many new competitors decide to enter at the first stage.

Lemma 3 *When the merger is allowed the SPNE at $t = 1$ depends on F* and *n. If*

$$\begin{cases} \underline{F} < F \leq F_0, \\ n < n_0, \end{cases} \tag{10}$$

where $F_0 = \left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2$ *and* $n_0 = \frac{\sqrt{12r(a-c)-11r^2}-3r}{2r} < n_1$, *then*

1. *only one firm decides to enter by producing* $\frac{3(a-c)-r(n+4)}{3(n+1)}$*;*
2. *output of each no-merged incumbent is* $\overline{K}$*;*
3. *the merged incumbent holds excess capacity by producing* $\frac{3(a-c)+r(2n-1)}{3(n+1)} \in \left(\overline{K}, 2\overline{K}\right)$.

Industry output is

$$Q_1^A = \frac{3n(a-c) - r(2n-1)}{3(n+1)}. \tag{11}$$

If $F_0 < F \leq \overline{F}$, *then*

1. *no entry occurs;*

2. *output of each no-merged incumbent is*

$$\begin{cases} \frac{a-c-2r}{n} \in \left(\overline{K}, 2\overline{K}\right) & \text{for} \quad n < n_1, \\ \overline{K} \quad \text{for} \quad n \geq n_1. \end{cases}$$

3. *the merged one produces*

$$\begin{cases} \frac{a-c+r(n-2)}{n} \in \left(\overline{K}, 2\overline{K}\right) & \text{for} \quad n < n_1, \\ 2\overline{K} \quad \text{for} \quad n \geq n_1. \end{cases}$$

Industry output is

$$Q_1^A = \begin{cases} \frac{(n-1)(a-c)-r(n-2)}{n} & \text{for} \quad n < n_1, \\ n\overline{K} \quad \text{for} \quad n \geq n_1. \end{cases} \tag{12}$$

Figure 2 depicts in the plane (n, F) the two areas where entry occurs and where it does not.

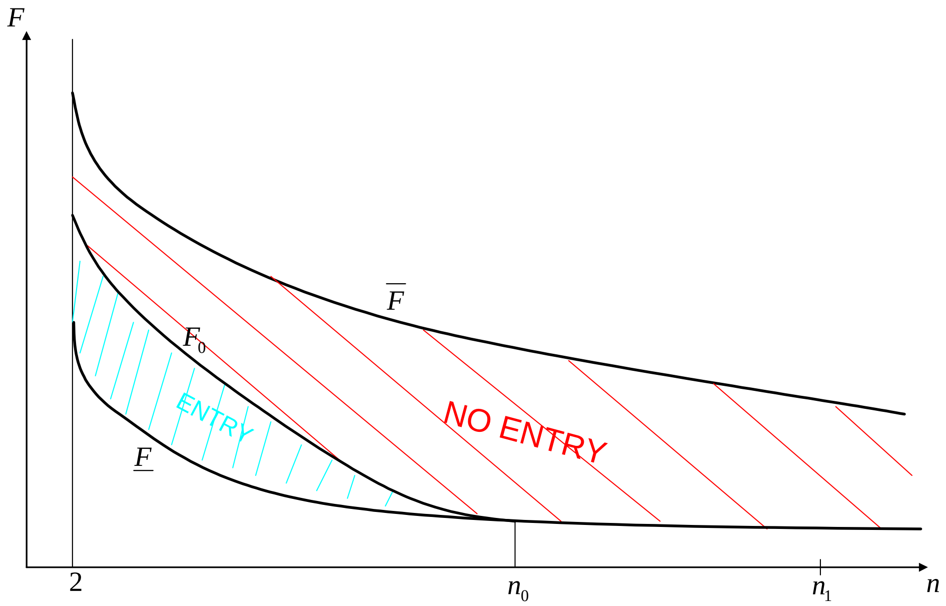

Figure 2: Entry choice when the merger is allowed.

An incumbent with huge capacity due to merger is present which reduces potential entrants' profits. Nevertheless note that the merged incumbent's production is increasing in n: for low n prospective profits are sufficiently high to ensure entry of one competitor if the set-up cost F is small. For higher F none decides to enter: the no-merged incumbents have the possibility of producing more by enlarging the capacity if $n < n_1$, while they are not able to enlarge it if $n \geq n_1$.

Lemma 4 *When the merger is blocked the SPNE at $t = 1$ is such that only one firm decides to enter by producing $\overline{K}$ and the incumbents produce $\overline{K}$ as well, thereby not expanding the capacity. Industry output is*

$$Q_1^B = n\overline{K}. \tag{13}$$

The symmetric incumbents produce up to the installed capacities and find it not profitable to enlarge them. This enables a new firm to enter and get a market share such that profits are sufficiently high to recover the set-up cost F. Blocking the merger ensures that a new competitor meets exactly the excess demand brought about by the failure of an incumbent at $t = 0$. Indeed, $Q_1^B = Q_{-1}$: the industry output is at the same level as before the failing firm's exit.

Lemmas 3 and 4 show the controversial effect at $t = 1$ of allowing the merger: holding excess capacity permits the merged firm to expand output at a lower marginal cost and reduce price when entry is threatened, thereby involving a reduction of entrants' prospective profits. If (10) does not hold, blocking the merger is the only mean for profits of one entrant to be sufficient to recover the entry cost.

4 Consumer Welfare

The analysis proceeds by checking whether the merger must be either allowed or blocked on the basis of consumer welfare. One-period surplus is defined as follows:

$$\int_0^Q (a - Q)\, dQ - pQ \tag{14}$$

and it amounts to $Q^2/2$, thereby being an increasing function of the industry output.

We compute the surplus gap at $t = 0$, which we denote with ΔS^0, between the situation where the merger is allowed and the one where it is blocked. In symbols

$$\Delta S^0 = \frac{\left(Q_0^A\right)^2}{2} - \frac{\left(Q_0^B\right)^2}{2}, \tag{15}$$

where recall that $Q_0^{A(B)}$ represents the industry output at $t = 0$ when the merger is allowed (blocked). We get

$$\Delta S^0 = \begin{cases} \frac{1}{8}\frac{(a-c+rn)[(4n-3)(a-c)-r(3n-4)]}{(n+1)^2} & \text{for } \ n < n_1, \\ \frac{2n-1}{2}\overline{K}^2 & \text{for } \ n \geq n_1. \end{cases} \tag{16}$$

which is positive.

Remark 1 *At $t = 0$, consumer surplus is higher when the merger is allowed.*

Allowing the merger gives a benefit in terms of consumer surplus because it prevents shortage of output of the failing firm. Absent the merger, demand would exceed significantly supply, hence price would increase involving a consumer surplus reduction. The requirement (iii) of the FFD's law is intended to avoid such a situation.

Yet, we argue that the above benefit must be traded off with a potential loss due to entry deterrence. To this aim, we compute the value

$$\Delta S^1 = \frac{\left(Q_1^B\right)^2}{2} - \frac{\left(Q_1^A\right)^2}{2}, \tag{17}$$

which represents the surplus gap at $t=1$ between the scenario where the merger is blocked and the one where it is allowed. If (10) holds, we get

$$\Delta S^1 = -\frac{r}{6}\frac{6n\,(a-c)-(5n-1)\,r}{3\,(n+1)}, \tag{18}$$

which is negative; by contrast, if $F_0 < F \leq \overline{F}$

$$\Delta S^1 = \begin{cases} \frac{[(a-c)-r(n+2)]\left[\left(2n^2-1\right)(a-c)-r\left(2n^2-n-2\right)\right]}{2n^2(n+1)^2} > 0 \ \text{ for } \ n < n_1, \\ 0 \ \text{ for } \ n \geq n_1. \end{cases} \tag{19}$$

Remark 2 *At $t=1$, if (10) holds consumer surplus is lower when the merger is blocked; if $F_0 < F \leq \overline{F}$ it is higher for $n < n_1$ and equal for $n \geq n_1$.*

A low cost of entry combined with high industry concentration makes entry being never deterred: allowing the merger gives a welfare benefit not only at $t=0$ (as pointed out in Remark 1), but also at $t=1$. Otherwise, the merged firm deters entry and the aforementioned trade-off arises: if the merger is allowed consumer surplus is higher at $t=0$ for there is no shortage of output, but it is lower at $t=1$ for entry is deterred and the merged firm holds capacity in excess, thereby reducing industry output.[8] Nonetheless, the trade-off disappears with relatively low industry concentration because the merged firm is exploiting the entire capacity $2\overline{K}$, thereby compensating exactly the absence of a potential entrant which would have produced $\overline{K}$ at equilibrium.

Last step of the analysis consists of going through the above trade-off to determine whether the FFD law prescriptions may reduce welfare of consumers, contrary to their purposes. To this aim we introduce the following function

$$D\,(n) = \Delta S_1 - \Delta S_0, \tag{20}$$

which represents the overall, i.e. at both $t=0$ and $t=1$, surplus gap between the situation where the merger is blocked and the situation where it is allowed.

[8] More exactly, for $n < n_1$ the merged incumbent restricts production below its capacity, whereas the no-merged incumbents expand their one. The former effect dominates the latter, so that industry output is higher when the merger is blocked: $Q_1^B > Q_1^A$.

We have already noted that if (10) holds ΔS_1 is negative, hence $D(n) < 0$. In such a case allowing the merger is better for consumers because it permits assets of the failing firm remain into the market without raising barriers to entry. We now turn to the situation where $F_0 < F \leq \overline{F}$. Recall that $\Delta S_1 = 0$ if $n \geq n_1$, therefore $D(n) < 0$ and allowing the merger is better for consumer because it does not involve any output reduction at $t = 1$ compared to the case of blocked merger. If $n < n_1$, in contrast, $\Delta S_1 > 0$ and the sign of $D(n)$ is studied in Proposition 1.

Proposition 1 *Blocking the merger is better from the consumer welfare view point if*

$$\begin{cases} n < 3, \\ F_0 < F \leq \overline{F}. \end{cases} \tag{21}$$

Otherwise, allowing the merger is better from the consumer welfare view point.

Under the FFD law gain represented by ΔS_0 would induce to allow the merger. Yet, when the entry cost is relatively high the merged firm deters entry. Moreover, the more the market is concentrated, the bigger is the output restriction (as it occurs when the merger is allowed) compared to the situation of fully exploitation of industry capacity (as it occurs when the merger is blocked) because a raising price strategy is highly profitable when the merged incumbent owns a big market share. In this case the merger should be stopped in order to preserve competition in the industry.

5 Concluding Remarks

According to the third requirement of the FFD law, allowing a horizontal merger gives a consumer welfare gain compared to the case where the merger is blocked and the failing firm's assets exit the market.

This paper argues that a trade-off between preservation of assets and (long-run) potential entry deterrence should be taken into account. Indeed, permitting an incumbent to own huge capacity as a consequence of the merger augments the height of entry barriers because the merged firm can increase output at a lower marginal cost. This reduces prospective profits of new entrants and, when entry is actually deterred, it may produce harmful effects on the consumer welfare.

We find that losses due to reduced competition dominates gains due to no shortage of output when the following two conditions are satisfied: (1) entry cost is relatively high, so that the merged firm deters entry, (2) market is highly concentrated so that it can conveniently exercises its market power and increases the price by retaining a significant amount of capacity in excess. In such a case, a strictly application of third requirement would lead to a lower consumer surplus than what it would be obtained by blocking the merger.

This result suggests that there might be scope for improving the current design of the FFD law and calls for more stringent conditions which must be met to apply the concept of a rescue merger. Even if we believe that the simple framework we employ is sufficient to state our results with robustness, further research in this area should extend the current analysis to an infinite horizon and by considering asymmetric firms with respect to production costs so as to fully endogenize the cause of the failure and the subsequent merger process.

6 Appendix

(Lemma 1). The merged firm solves the following problem:

$$\max_{q^M} \left[a - c - \left(\sum_{k}^{n-2} q^{I_k} + q^M \right) \right] q^M \tag{22}$$
$$s.t. \;\; q^M \leq 2\overline{K}.$$

where $\sum_k q^{I_k}$ and q^M are the quantities produced by the no-merged incumbents and the merged one, respectively. The solution to (22) is $q^M = \frac{a - \sum q^I - c}{2}$.

Simultaneously, the no-merged firm I_k solves the following problem:

$$\max_{q^I}\left[a-c-\left(\sum_{h\neq k}^{n-3} q^{I_h}+q^M+q^{I_k}\right)\right]q^{I_k} \tag{23}$$
$$s.t.\ \ q^{I_k}\leq \overline{K}.$$

The objective function of the problem (23) is increasing in $q^{I_k} \leq \frac{a-\sum q^{I_h}-q^M-c}{2}$. This upper bound is higher than $\overline{K}$, hence the solution to (23) is $q^{I_k}=\overline{K}$. By substituting this value in the merged firm reaction function, we get $q^M=\frac{3(a-c)+r(n-2)}{2(n+1)}$ which is higher than $\overline{K}$ for any n and lower than $2\overline{K}$ if $n<\frac{a-c-2r}{r}$. The result in the text follows.

(Lemma 2). The firm I_k solves the following problem:

$$\max_{q^I}\left[a-c-\left(\sum_{h\neq k}^{n-2} q^{I_h}+q^{I_k}\right)\right]q^{I_k} \tag{24}$$
$$s.t.\ \ q^{I_k}\leq \overline{K}.$$

The first derivative of the objective function is positive if and only if $q^{I_k}<\frac{a-\sum q^{I_h}-c}{2}$. This upper bound is higher than $\overline{K}$, hence the solution to (24) is $q^{I_k}=\overline{K}$.

(Lemma 3). We solve the game backwards by proceeding in three steps which we described in the text. For ease of exposition in this and next proposition we present just the equilibrium cases: the complete proof is available on request. Recall that if the merger is allowed there are $n-2$ symmetric incumbents I_k with capacity $\overline{K}$ and a merged incumbent with capacity $2\overline{K}$.

(a) We study last stage optimal quantities when m' entrants $E_{k'}$ decide to enter. The entrants reaction function is as follows:

$$R_A^{E_{k'}}=\frac{a-c-r-\left(q^M+\sum_k q^{I_k}+\sum_{h'\neq k'} q^{E_{h'}}\right)}{2}. \tag{25}$$

where c, r, q^M and $\sum_k q^{I_k}$ are defined above and q^E is the quantity produced by each entrant. The $n-2$ no-merged incumbents' reaction functions $R_A^{I_k}$ are symmetric:

$$\begin{cases} \frac{a-c-r-\left(q^M+\sum_{h\neq k} q^{I_h}+\sum_{k'} q^{E_{k'}}\right)}{2} & \text{if } \ 0 \leq q^M + \sum_{h\neq k} q^{I_h} + \sum_{k'} q^{E_{k'}} < (n-1)\,\overline{K}, \\ \overline{K} \ \text{ if } \ (n-1)\,\overline{K} \leq q^M + \sum_{h\neq k} q^{I_h} + \sum_{k'} q^{E_{k'}} \leq \frac{(n-1)(a-c)+2r}{n+1}, \\ \frac{a-c-\left(q^M+\sum_{h\neq k} q^{I_h}+\sum_{k'} q^{E_{k'}}\right)}{2} & \text{if } \ q^M + \sum_{h\neq k} q^{I_h} + \sum_{k'} q^{E_{k'}} > \frac{(n-1)(a-c)+2r}{n+1}. \end{cases} \tag{26}$$

Finally the merged incumbent reaction function is

$$R^M = \begin{cases} \frac{a-c-r-\left(\sum_k q^{I_k}+\sum_{k'} q^{E_{k'}}\right)}{2} & \text{if } \ 0 \leq \sum_k q^{I_k} + \sum_{k'} q^{E_{k'}} < (n-3)\,\overline{K}, \\ 2\overline{K} \ \text{ if } \ (n-3)\,\overline{K} \leq \sum_k q^{I_k} + \sum_{k'} q^{E_{k'}} \leq \frac{(n-3)(a-c)+4r}{n+1}, \\ \frac{a-c-\left(\sum_k q^{I_k}+\sum_{k'} q^{E_{k'}}\right)}{2} & \text{if } \ \sum_k q^{I_k} + \sum_{k'} q^{E_{k'}} > \frac{(n-3)(a-c)+4r}{n+1}. \end{cases} \tag{27}$$

Let $x > \overline{K}$ be the output of no-merged incumbents which decide to produce more than the capacity. Let $y = \overline{K}$ be the output of no-merged incumbents which decide to produce exactly the capacity. Finally, let $z < \overline{K}$ be the output of no-merged incumbents which decide to produce less than the capacity. Moreover, let $X > 2\overline{K}$, $Y = 2\overline{K}$ and $Z < 2\overline{K}$ be the corresponding output of the merged incumbent.

We compute last stage optimal quantities with entry for the situation where all $n-2$ no-merged incumbents produce y, the merged incumbent produces either Y or Z and the entrants q^E. In the former case the solution is defined by the following system:

$$\begin{cases} y = \overline{K}, \\ q^E = \frac{a-c-r-Y,Z-(n-2)y-(m'-1)q^E}{2}, \\ Y = 2\overline{K}, \end{cases} \tag{28}$$

where the reaction function y appears $n-2$ times and q^E appears m' times. We get $q^E = \frac{1}{m'+1}\overline{K}$. To have the no-merged incumbents producing y, expression (26) requires $(n-1)\,\overline{K} \leq Y + (n-3)\,y + m'\frac{y}{m'+1} \leq \frac{(n-1)(a-c)+2r}{n+1}$, i.e. $n \geq \frac{m'(a-c)-r(2m'+1)}{r(m'+1)}$. To have the merged incumbent producing Y expression (27) requires $(n-3)\,\overline{K} \leq (n-2)\,y + m'\frac{y}{m'+1} \leq \frac{(n-3)(a-c)+4r}{n+1}$, i.e.

$n \geq \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$. Given that $\frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)} > \frac{m'(a-c)-r(2m'+1)}{r(m'+1)}$, we conclude that this solution is admissible if $n \geq \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$.

If the merged incumbent produces Z, the system is

$$\begin{cases} y = \overline{K}, \\ q^E = \frac{a-c-r-Y,Z-(n-2)y-(m'-1)q^E}{2}, \\ Z = \frac{a-c-(n-2)y-m'q^E}{2}. \end{cases} \tag{29}$$

We get $q^E = Z - r$ and $Z = \frac{3(a-c)+r[m'(n+1)+n-2]}{(m'+2)(n+1)}$. Note that $Z < 2\overline{K} \Leftrightarrow n < \frac{(2m'+1)(a-c)-r(3m'+1)}{r(m'+1)}$. In such a case, expression (26) requires $(n-1)\,\overline{K} \leq Z + (n-3)\,y + m'\,(Z-r) \leq \frac{(n-1)(a-c)+2r}{n+1}$, which is always true if $m' \geq 1$, and true for $n \geq n_1$ if $m' = 0$; expression (27) requires $(n-2)\,y + m'\,(Z-r) > \frac{(n-3)(a-c)+4r}{n+1}$, which is satisfied if $n < \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$. Note that $\frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)} = n_1$ if $m' = 0$: we conclude that this solution is admissible for $n < \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$ if $m' \geq 1$ and not admissible if $m' = 0$.

We study the situation where $m' = 0$, all $n-2$ no-merged incumbents produce x and the merged one produces Z. The system is

$$\begin{cases} x = \frac{a-c-r-Z-(n-3)x}{2}, \\ Z = \frac{a-c-(n-2)x}{2}. \end{cases} \tag{30}$$

We have $x = \frac{a-c-2r}{n}$ and $Z = x + r$. These two values are acceptable if $n < n_1$. Moreover we need $0 \leq q^M + \sum_{h \neq k} q^{I_h} = x + r + (n-3)\,x < (n-1)\,\overline{K}$, which is verified if $n < n_1$, and $\sum_k q^{I_k} = (n-2)\,x > \frac{(n-3)(a-c)+4r}{n+1}$, which is also verified if $n < n_1$. This solution is thus admissible if $n < n_1$.

From the above analysis we infer that if m' entrants decide to enter, then the value of third stage optimal quantities depends on n. If $n < \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$, then all no-merged incumbents produce exactly their capacity $\overline{K}$, output of the merged incumbent is $Z = \frac{3(a-c)+r[m'(n+1)+n-2]}{(m'+2)(n+1)}$ and each entrant produces $q^E = Z - r = \frac{3(a-c)-r(n+4)}{(m'+2)(n+1)}$; the entrants' profit is $\left(\frac{3(a-c)-r(n+4)}{(m'+2)(n+1)}\right)^2 - F$. Nonetheless, if $m' = 0$, then all no-merged incumbents produce $\frac{a-c-2r}{n} > \overline{K}$ and the merged incumbent produces $\frac{a-c+r(n-2)}{n} < 2\overline{K}$. If $n \geq \frac{(2m'+1)(a-c)-r(3m'+2)}{r(m'+1)}$, then both no-merged incumbents and the merged one produce exactly their capacity, $\overline{K}$ and $2\overline{K}$, respectively; each entrant produces $q^E = \frac{1}{m'+1}\overline{K}$ and its profit is $\left(\frac{1}{m'+1}\overline{K}\right)^2 - F$.

(b) We deduce that after observing that m' entrants will enter, only the no-merged incumbents when $m' = 0$ decide to expand the available capacity at the second stage of the game.

(c) We study the first stage decision of entry by comparing the entrants' profits in case of entry to their outside option, which is assumed to be equal to zero. Recall that entrants' profit when $n < \frac{(2m'+1)(a-c)-r(3m'+1)}{r(m'+1)}$ amounts to $\left(\frac{3(a-c)-r(n+4)}{(m'+2)(n+1)}\right)^2 - F$. This value is nonnegative if $\underline{F} < F \leq \left(\frac{3(a-c)-r(n+4)}{(m'+2)(n+1)}\right)^2$. The interval $\left(\underline{F}, \left(\frac{3(a-c)-r(n+4)}{(m'+2)(n+1)}\right)^2\right]$ is nonemtpy iff $m' < \frac{(a-c)(n+4)-r\left(n^2+4n+6\right)}{(n+1)(a-c-r)} = m'_0$. Note that $m'_0 \leq 2$, hence m' must not exceed 1 to have a necessary condition for entry. If $m' = 1$ profit of the only entrant amounts to $\left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2 - F$. This value is nonnegative if $\underline{F} < F \leq \left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2$. The interval $\left(\underline{F}, \left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2\right]$ is nonemtpy iff $n < \frac{\sqrt{12r(a-c)-11r^2}-3r}{2r}$. On the contrary, profit of m' entrants when $n \geq \frac{(2m'+1)(a-c)-r(3m'+1)}{r(m'+1)}$ amounts to $\left(\frac{1}{m'+1}\overline{K}\right)^2 - F$, which is negative for any $m' \geq 1$.

From the overall analysis it follows that the SPNE depends on F and n:

1. if $\underline{F} < F \leq \left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2$ and $n < n_0$, then only one entrant decides to enter and the incumbents decide not to expand the capacity: equilibrium quantities are $\overline{K}$ for each no-merged incumbent, $\frac{3(a-c)+r(2n-1)}{3(n+1)}$ for the merged incumbent and $\frac{3(a-c)-r(n+4)}{3(n+1)}$ for the entrant;

2. if $\left(\frac{3(a-c)-r(n+4)}{3(n+1)}\right)^2 < F \leq \overline{F}$, no entrant decides to enter, (i) the no-merged incumbents expand the capacity to produce $\frac{a-c-2r}{n}$ (which is less than $2\overline{K}$ for any n and higher than $\overline{K}$ for $n < n_1$) and the merged incumbent produce $\frac{a-c+r(n-2)}{n}$ (which is higher than $\overline{K}$ for any n and less than $2\overline{K}$ for $n < n_1$) for $n < n_1$; (ii) all incumbents produce exactly their capacity for $n \geq n_1$.

(Lemma 4). The game is solved backwards. There are $n-1$ symmetric incumbents I_k with capacity $\overline{K}$ and whose reaction functions $R_B^{I_k}\left(\sum_{h\neq k}^{n-2} q^{I_h}, \sum_{k'} q^{E_{k'}}\right)$ are given by

$$\begin{cases} \frac{a-c-r-\left(\sum_h q^{I_h}+\sum_{k'} q^{E_{k'}}\right)}{2} \text{ if } 0<\sum_h q^{I_h}+\sum_{k'} q^{E_{k'}}<(n-1)\overline{K}, \\ \overline{K} \text{ if } (n-1)\overline{K}\leq \sum_h q^{I_h}+\sum_{k'} q^{E_{k'}}\leq \frac{(n-1)(a-c)+2r}{n+1}, \\ \frac{a-c-\left(\sum_h q^{I_h}+\sum_{k'} q^{E_{k'}}\right)}{2} \text{ if } \sum_h q^{I_h}+\sum_{k'} q^{E_{k'}}>\frac{(n-1)(a-c)+2r}{n+1}. \end{cases} \tag{31}$$

The entrants reaction function is defined as follows:

$$R_B^E=\frac{a-c-r-\left(\sum_k q^{I_k}+\sum_{h'\neq k'} q^{E_{h'}}\right)}{2}. \tag{32}$$

(a) We study last stage optimal quantities when m' entrants decide to enter. We focus on two cases: all incumbents produce either y or z. In the former case we have

$$\begin{cases} y=\overline{K}, \\ q^E=\frac{a-c-r-(n-1)y-(m'-1)q^E}{2}, \end{cases} \tag{33}$$

where the reaction function y appears $n-1$ times and q^E appears m' times. The entrant optimal output is derived by (32) and it is equal to $\frac{2}{m'+1}y$. To have the incumbents with output y expression (31) imposes $(n-1)\overline{K}\leq(n-2)y+m'\frac{2}{m'+1}y\leq\frac{(n-1)(a-c)+2r}{n+1}$, which is satisfied iff $n\geq\frac{(m'-1)(a-c)-2m'r}{2(m'+1)}$. When all incumbents produce z, we have

$$\begin{cases} z=\frac{a-c-(n-2)z-m'q^E}{2}, \\ q^E=\frac{a-c-r-(n-1)z-(m'-1)q^E}{2}. \end{cases} \tag{34}$$

We get: $q^E=z-r$ and $z=\frac{a-c+m'r}{n+m'}$. The entrants' profit is $\left(\frac{a-c-nr}{n+m'}\right)^2-F$. Note that $\frac{a-c+m'r}{n+m'}<\overline{K}$ iff $n<\frac{(m'-1)(a-c)-2m'r}{2(m'+1)}$. This solution is not acceptable because (i) if $m'\leq 1$, then $\frac{(m'-1)(a-c)-2m'r}{2(m'+1)}<0$ and n should be negative; (ii) if $m'>1$, then $\left(\frac{a-c-nr}{n+m'}\right)^2-\underline{F}<0$ and we anticipate that none enters.

It follows that if m' entrants decide to enter and $n\geq\frac{(m'-1)(a-c)-2m'r}{2(m'+1)}$ all incumbents produce exactly their capacity $\overline{K}$ and the entrants choose to produce $\frac{2}{m'+1}\overline{K}$. In such a case entrants' profit is $\left(\frac{2}{m'+1}\overline{K}\right)^2-F$. Note that the amount $\left(\frac{2}{m'+1}\overline{K}\right)^2 - \underline{F}$ is positive iff $m' < \frac{n+3}{n+1}$, i.e. $m' = 1$, and that $\overline{K}^2 - \overline{F}$, which represents profit of one entrant if F is maximum, is equal to zero. We anticipate that only one firm enters in the first stage for any n.

(b) We deduce that after observing entry, in the second stage the incumbents decide not to expand the available capacity.

(c) We recall that in the first stage one entrant decides to enter because its profits are not lower than the outside option. It follows that the SPNE is such that only one entrant decides to enter, the incumbents do not expand the capacity because they produce $\overline{K}$, finally the entrant's output is also $\overline{K}$.

(Proposition 1). If $F_0 < F \leq \overline{F}$ the value of $D(n)$ when $n < n_1$ is

$$\frac{r^2\left(3n^4+4n^3+12n^2-16n-16\right)-2r(a-c)\left(2n^4+n^3+14n^2-4n-8\right)}{2n^2(n+1)^2}+ \\ -\frac{(a-c)^2\left(4n^3-11n^2+4\right)}{2n^2(n+1)^2}. \tag{35}$$

To study the sign of (35) note that the coefficients of both r^2 and $r(a-c)$ are positive, while the one of $(a-c)^2$ it is positive if $n \geq 3$. In such a case, we verify that the coefficient of r^2 is lower than the coefficient of $r(a-c)$ and we remind that $r^2 \leq r(a-c)$ to conclude that $D(n) < 0$ if $n \geq 3$. If $n = 2$, we can write

$$D(2) = \frac{10r^2 - 20r(a-c) + (a-c)^2}{9}, \tag{36}$$

which is nonnegative under Assumption 2.

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